Integrated Subsurface Evaluation

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Rebecca Sawyer
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Via email: rsawyer@excelsiormining.com

RE: Fracture Gradient Testing and Analysis, Gunnison Copper Project, Dragoon, Arizona

Dear Ms. Sawyer:

In accordance with the scope of work presented in our proposal dated June 19, 2015, RAS is pleased to provide this brief letter report of the analysis of formation fracture pressure gradient data collected during pressure testing in six boreholes at the above referenced site. This letter report presents the objective, scope of work conducted, and summarizes the results of the data evaluation. Attached to this letter are graphs of time vs. pressure data for each test, and tables with summarized pressure data for each test presenting pressure gradient per formation, in each borehole, using two different gradient calculation methods.

Sincerely,
RAS, INC.

Steven Truesdale
Steven Truesdale, P.G.
Senior Log Analyst

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Tables
Appendix A – Peak Pressure Method Graphs
Appendix B - Intercept Method Graphs
Digital Data Files
- Raw Pressure Files
- Selected Pressure Files
- Excel Spreadsheets
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Objective

We understand that the Excelsior Mining Corporation has applied for an Underground Injection Control (UIC) permit for planned injection wells at the Gunnison Site. In support of the permit application, Excelsior requested an assessment of formation fracture pressure for selected formations. To accomplish this, RAS collected packer pressure data from testing within 28 intervals in six existing boreholes. The objective of the packer testing was to characterize formation fracture pressure in six units at the site through an evaluation of interval-specific packer pressure and flow data during high pressure injection procedures.

Scope of Work

RAS conducted packer pressure testing in six existing boreholes at the site; NSD-037, NSD-043, NSM006, NSM-007, NSM-008, and NSM-009. The boreholes were recently drilled using an approximate 3.75 to 5.15-inch diameter bit. The test interval depths ranged from between 698.4 and 705 feet below ground surface (bgs) in borehole NSD-037, to between 1,495.5 and 1504.5 feet bgs within borehole NSD-043. Each test interval was between approximately 7 and 10 feet in length. For the purposes of analysis, the depth to the approximate center of each interval was used for breakthrough pressure calculations. Additional detail on the field methodology is presented in the Methodology section, below.

RAS arrived at the subject site on June 18, 2015, and conducted testing activities between June 20 and July 3, 2015. Upon arrival at the site on June 20, RAS personnel met with Excelsior staff and participated in a project kick-off meeting to discuss site health and safety protocol and schedule, prior to mobilizing to the first borehole. Upon completion of the project kick-off meeting, RAS mobilized to the first borehole, NSD-043, to begin set-up and testing. A summary of the work conducted at each well is included in this section of the letter report, and a brief discussion of conclusions is presented in the Conclusions section, below.

The test data, including bit depth during testing, test interval depths, breakthrough formation pressure, and formation pressure gradient (breakthrough pressure/depth to interval center) are included in the attached tables. Appendix A contains graphs presenting downhole pressure from transducers located within, above and below each test interval, injection pressure at the surface, and total injected volume with respect to (wrt) time. Also on these plots are the results from the direct pick of the estimated breakthrough pressure and the results of the fracture gradient calculation for each test interval. Appendix B contains graphs presenting the downhole injection pressure at the test interval and instantaneous injection flow rate wrt time. Also included on each graph is a brief summary of the calculations for fracture gradient in each test interval.

NSD–043

On June 20, 2015, RAS arrived at the borehole at approximately 0605 and began site set-up activities. Depth to water (dtw) was measured at 615.37 feet below ground surface (bgs). RAS ran a dummy tool to evaluate hole stability, and an obstruction was encountered at a depth of approximately 840 feet bgs. At 1215, the driller began a wiper run in the borehole in an attempt to clear the obstruction. During these activities, a second obstruction was encountered. The “wiper” or clean out run was completed at

approximately 1550, and RAS demobed from the site. On June 21, 2015, RAS remobilized to the borehole to install the packer (on HQ pipe) and begin testing. Between June 21 and 23, RAS tested six intervals within borehole NSD-043. RAS completed the testing and mobilized off the borehole at 1700 on June 24, 2015.

NSM–008

On June 24, RAS arrived at the borehole at approximately 0500 and began site set-up activities. Depth to water (dtw) was measured at approximately 607 feet bgs. On June 24, RAS conducted pressure testing in the first four of five intervals within NSM-008. Upon completion of the testing on June 24, RAS demobed from the site at 1400 due to severe weather. RAS returned to borehole NSM-008 at 0455 on June 25 and conducted pressure testing on the fifth and final interval within NSM-008. At 1200, RAS demobilized from the borehole and moved to a third borehole (NSM-009) to begin set up.

NSM–009

On June 25, RAS arrived at the borehole at approximately 1200 and began site set-up activities. Drill rod was installed and the packer was cleaned and readied for installation. No pressure testing was conducted in NSM-009 on June 25, and RAS demobilized from the site at 1700. RAS arrived at NSM-009 on June 26, at 0540 and begin equipment set up. Depth to water was measured at 593.09 feet bgs. On June 26, the first of six planned intervals was tested, then RAS demobilized from the borehole due to severe weather. On June 27, RAS arrived at the borehole at 0500 and began site set-up activities. Two additional intervals were tested, and RAS completed pressure testing. Packer removal began at approximately 1230. While the drillers continued pulling core pipe from the borehole, RAS departed the borehole at approximately 1350 and mobilized to the fourth borehole (NSM-006) to begin testing. Three planned intervals within this borehole could not be tested due to borehole size and/or sediment plugging. The corehole was drilled using an oversized HQ core bit, resulting in a borehole diameter of approximately 5.15 inches. Furthernore, the well had apparently not been completely developed after drilling as the wellbore fluids contained a significant amount of suspended sediment. The presence of these sediments was unknown at the time of testing and subsequently fouled the packers during initial inflation. Approximately 3-4 hours were expended to clean out both packers and internal packer components at the surface. As such, three total intervals were tested in this borehole.

NSM–006

On June 27 at approximately 1400, RAS arrived at the borehole and began site set-up activities. The drillers arrived at 1430 and began installing drill rod and conducted a wiper run. After completion of site set-up, RAS departed the site at 1650. On June 28, RAS arrived at the borehole at 0500, and began preparations for pressure testing. Depth to water was measured at 634.93 feet bgs. On June 24, RAS conducted pressure testing in the first three of six intervals within NSM-006. Upon completion of the testing on June 28, RAS demobilized at 1700. RAS returned to borehole NSM-006 at 0500 on June 29 to complete pressure testing on the remaining three planned test intervals. RAS completed testing and departed the site at 1640 on June 29.

NSM–007

On June 30, RAS arrived at borehole NSM-007 at approximately 0500 and began site set up activities. Depth to water was measured at 651.42 feet bgs. On June, 30 RAS conducted pressure testing in six planned intervals within this borehole. Upon completion of the testing on June 30, RAS demobilized

from the site at 1710. Complete breakdown and pack up of site equipment was planned for the following morning. On July 1, RAS arrived at the well at 0515, completed site demobilization and moved all equipment to the final test well, NSD-037.

NSD–037

On July 1, RAS arrived at borehole NSD-037 at approximately 0650 and began site set-up activities. The drillers arrived at the well at 1200, and began installation of rod. During rod installation, an obstruction was encounteed at 740 feet bgs. While attempting to clear the obstruction, the drillers and RAS departed the site at 1415 due to severe weather. Operations were resumed at 1530 after the weather cleared. However, due to sand clogging the bit, final rod installation could not be completed. Therefore, RAS secured all equipment and departed the site at 1700. RAS arrived back on the borehole on July 2 at 0500. After unsuccessful attempts at clearing the obstruction, the drillers received direction from Excelsior to set the casing at 750 feet and for RAS to log only above the obstruction. After flushing, dtw was measured at approximately 430 feet bgs. On July 2, three intervals were tested above 750 feet bgs. At 1745, RAS completed testing in NSD-037, secured all equipment, and departed the site.

Equipment

The straddle packer system deployed for this project was manufactured by Inflatable Packer International, LLC (IPI) (details can be found at www.inflatable-packers.com). IPI's Model STX-60 was primarily operated in the wireline mode. Three self-contained, direct reading pressure transducers were installed in the packer and recorded interval specific pressure at one second intervals. A fourth pressure transducer was plumbed into the flow manifold system and directly measured surface injection pressure. The pressure transducers used were Pioneer Petrotech Services Model PPS25 (www.pioneerps.com). The pressure transducers were secured within the packer assembly with one above the upper packer (#7158), one within the packed-off or test interval (#7130) and one below the bottommost packer (#5097). The surface pressure was measured on the flow module (#7323). This pressure transducer numerical designation was maintained throughout the project and is relevant for referencing specific pressure data files.

A CAT high pressure injection pump model 1580 was provided by the drilling contractor for injection procedures. Surge tanks were deployed in line with the injection pump to reduce pulsing (dramatic high frequency increases and corresponding decreases in pressure) associated with the hydraulic drive mechanism of the pump.

Methodology

A summary of the activities associated with our methodology and testing is provided below.

Pre-Mobilization

Prior to mobilization to the subject site, all equipment which had been designated for the project was inspected, assembled, and checked out for proper operation and calibration. The equipment was then re-packed for transport and mobilized to the site.

Borehole Activities

Arrival and set-up at the wellsite

Open wellhead

Check static water level

The water level prior to installation of the packer was measured and recorded in the field notes.

Set-up drill rig and work area

The drill rig (operated by Rouen Drilling of Clark's Fork, Idaho) was configured over the subject test well. The pipe trailer was positioned next to the drill rig and preparations were made to conduct a clean-out or "wiper run". This task was conducted to ensure obstructions were not present in the borehole prior to packer assembly installation in the well.

Conduct clean out run

The core barrel was advanced to below the deepest test interval to confirm open hole conditions.

Fill up water truck

Appropriate water (groundwater pumped from neighboring plant well) was provided by the client and acquired on site for injection procedures and brought by truck to the subject well. The water was off loaded to a slave tank at the borehole site.

Unpack and assemble packer

The straddle packer was unpacked, inspected and assembled near the drill rig. After initial tests in the first well, which used three (3) meter test interval spacing, all subsequent testing was conducted using two (2) meter test interval spacing. Two meter spacing was requested by the client so as to better locate the test interval with relationship to fractures, water bearing intervals and wellbore diameter.

Inspect rods

New drill rods were provided by the drilling contractor and their condition was confirmed by inspection. The rods were clean, in good condition and appropriate for the subsequent testing.

Decide mode of packer operation – i.e. either Run in on Rod (RIOR) or Wireline

All testing was conducted in the wireline mode after modifying an old core bit to permit the larger diameter, high pressure, packers to pass through. The wireline mode afforded more flexibility to retrieve the packer if necessary and protected the packer in the event of downward advancement of the pipe string.

Set-up high pressure pump and surface manifold

The hydraulically powered injection pump was stationed near the drill rig and work trailer and was configured so as to pump from the water tank through the surface manifold system into the wellhead.

Set-up packer for surface inflation test

The packer assembly was configured and loaded into the drill rod.

Program the pressure transducers

During packer set-up, the pressure transducers were programmed to initiate automatic data collection. The pressure transducers were then installed in the packer assembly. Care was exercised to ensure the same pressure transducer was maintained at the same location relative to the packer assembly throughout all of the testing on this project.

Run packer through stages as surface test

Proper operation of the packer assembly was conducted near the surface prior to running the equipment down the hole.

Trip rod to deepest test interval and deploy packer on wireline

After the drill rod was advanced to the requisite feet above the top of the deepest test interval, the packer was installed in the drill rod and lowered by wireline so as to land on the water-tight landing ring on the core barrel assembly.

Perform apparatus leakage test

With the packer assembly in place, water was added to the standpipe, and an apparatus leak test was conducted.

Inflate packer

The packer assembly was inflated to target inflation pressure. Target packer inflation pressure was determined by manufacturer's guidelines, depth of test interval and anticipated maximum injection pressure.

Conduct initial test

At the conclusion of packer inflation, packer valve settings were adjusted to inject water into the test interval. The injection pump was initiated, and flow was recirculated at the surface. By adjusting the recirculation valve (diverting less flow to recirculation and more flow downhole), downhole pressure was gradually increased. During this period, manual recordings of injection pressure, flow rate, and total gallons, were recorded with respect to real time typically at 30second intervals. Simultaneously, the digital pressure transducer (#7323) was recording

pressure at the manifold at 1-second intervals. The test was concluded when either break pressure or maximum achievable pressure was observed.

Deflate packers

At the conclusion of injection procedures, the packer settings were adjusted to allow deflation of the packers.

Trip rod up to next test interval

Based on borehole conditions, the packer assembly was either tripped to surface or allowed to remain at the end of the pipe string and tripped up to the next test interval.

Perform next test(s) until hole is completed

The downhole testing procedures were repeated until testing at all selected intervals was completed.

Trip rod out and recover packer

At the conclusion of the last test interval, the packer was tripped out of the borehole, and the drill rod was removed from the borehole.

Download transducers and check for good packer seals

With the packer assembly at the surface, the pressure transducers were removed and the digital data were downloaded. The packer glands were inspected for damage or excess wear.

Disassemble packer, manifold and work area

At the conclusion of testing, the packer was disassembled and secured on the pipe trailer for transport to the next well. The work area was broken down with the flow manifold assembly stored in the trailer to be ready for mobilization to the next well.

Move rig, equipment and data trailer to next location

Data Analysis

Two methods of data analysis were applied to the data collected at each test interval. These methods were the Peak Pressure Method and the Intercept Method. A brief summary of each approach is provided below. A more detailed explanation of these and other methods can be found in the references, a list of which has been attached.

Peak Pressure Method

Appendix A presents the pressure and injection data collected at each test interval from the subject boreholes. These data were used to estimate the peak pressure (Pp) observed during injection procedures. Four (4) pressure responses are presented with respect to time; pressure from the surface/ flow manifold (red line), pressure from the upper transducer (above the top packer, in magenta), pressure from the test interval (between the two packers, in green) and pressure from the lower transducer (below the bottom packer, in blue). The Volume (total gallons) injected with respect to time is presented as a red dot. In general, the peak pressure associated with causing the formation to break, or fracture, corresponds with the time at which a notable change in slope, or point of inflection, of Volume Injected occurs. For each graph, the interpreted peak pressure (Pp) value, and time of peak pressure (tp) are plotted on the graph. The fracture gradient is calculated by dividing the peak pressure by the depth of the deepest point of the tested interval.

The other pressure channels presented on each figure are relevant, as the upper and lower pressure values suggest whether any leakage or breakthrough occurred during the injection testing. In two tests, the data suggest that breakthrough to the lower interval occurred. In each case, the data suggested that this breakthrough occurred within the formation, as a result of the rock breaking and not leakage past the packers along the wall of the borehole.

Flow Rate versus Pressure Line Intercept Method

Appendix B presents the instantaneous flow rate (gallons per minute) versus the corresponding test interval pressure data collected from each test interval at the subject test boreholes. These data were used to calculate the intersection point (intercept) of the two best fit lines corresponding to the prebreak and post-break flow rate and test interval pressure data points. To indentify the data points used for each linear regression, a box is drawn around the corresponding data points and labeled as Line 1 (pre-break) and Line 2 (post-break). The resulting linear equation for each data group is provide in the Analysis Summary box for each graph. The intercept is calculated by simultaneously solving the two linear equations. The intercept point for each set of linear equations and the resulting intercept pressure (Pin) are also reported. The fracture gradient is calculated by dividing the intercept pressure by the depth of the deepest point of the tested interval.

Results Summary

A summary of the data collected and presented on the attached tables and graphs is included in this section. As described above, two methods were applied to estimate the formation breakthrough pressure for each test. Table A includes the results from application of the Peak Pressure method. Table B includes the results from application of the Intercept method. In both tables, test intervals that included two or more geologic units were counted separately for each unit.

In general, the pressure gradients estimated using the slope intercept method were slightly less than those estimated from the direct pick method. Additional detail about the applied field methods have been included in the Methodology section and the Field Notes (attached).

NSD–043

Six intervals were pressure tested in NSD-043; two intervals within the Martin formation, three within the Escabrosa formation, and one within the Horquilla formation. For each interval tested, estimates of the breakthrough pressure were calculated using both direct and line intercept methods.

The pressure values and depths chosen to evaluate pressure gradient are presented on each figure and summarized in the data table. Pressure gradients ranged from a low of 0.78 psi/foot during test #3a (using the Intercept calculation method) at a depth of 1,404.5 feet bgs within the Escabrosa formation, to 1.99 (Peak method) during test #4, at a depth of 1,170 feet within the Escabrosa formation. For all tests, the observed maximum pressure recorded by the pressure transducer in the test interval was used in the fracture gradeint calculation. No correction for submergence and the associated assumption of any hydraulic connection was made. On the contrary, the data across the site suggested that the intervals tested were not hydraulically conductive, nor innerconnected to any hydraulically conductive intervals prior to testing.

Two tests (#s 1b and 2) were conducted within the Martin formation at depths of 1,504.5 and 1,445.0 feet bgs, respectively. These two tests had peak breakthrough pressures of 1,925 and 2,000 psi respectively, yielding pressure gradients of 1.28 and 1.38, respectively. These two tests also had slightly lower pressure gradients of 1.04 and 1.18, using the Intercept method. The average formation pressure gradient project-wide (Martin formation) using the Peak method (total of ten tests from within three boreholes) was 1.55 psi/ft; the average pressure gradient using the Intercept method was 1.42 psi/foot. From within NSD-043 only, for all formations tested, the average formation pressure gradient (Peak method) was 1.38 psi/foot and 1.21 psi/foot (Intercept method).

Three tests (3a, 3b, and 4) were conducted within the Escabrosa formation at depths of 1,404.5, 1,405.5, and 1,170 feet bgs, respectively. These three tests had Peak breakthrough pressures of 1,380, 1,305, and 2,325 psi respectively, yielding pressure gradients of 0.98, 0.93, and 1.99 psi/foot respectively. Via the Intercept method, these three tests yielded breakthrough pressures of 1,090, 1,310, and 2,199 psi and were calculated to have pressure gradients of 0.78, 0.93, and 1.88 psi/foot, respectively. The Peak formation average pressure gradient project-wide was 1.30 psi/ft, and was 1.20 psi/foot using the slope intercept method. The three tests conducted within the Escabrosa formation in this well were the only tests conducted within this formation during this field effort.

The single test conducted within the Horquilla formation, test #5 at a depth of 996.5 feet bgs, was the only test conducted within this formation during this field effort. The formation average (from only a single test) was 1.70 psi/foot (Peak method) and 1.46 psi/foot using the Intercept method.

NSM–008

Five intervals were pressure tested in NSM-008, one interval within the Lower Abrigo formation, one from the Middle Abrigo formation, two from the Upper Abrigo formation, and one from a combined Upper and Middle Abrigo formation. Pressure gradients ranged from a low of 1.48 psi/foot during test #2 (Intercept method) at a depth of 1,054.6 feet bgs within the Middle Abrigo formation, to 2.00 psi/foot (test #1) at a depth of 1,239.5 feet using the Peak method, within the Lower Abrigo formation. The five tests had formation Peak breakthrough pressures of 2,485, 1,585, 1,800, 1,865, and 1,580 psi respectively, yielding formation pressure gradients of 2.01, 1.50, 1.78, 1.59, and 1.75 psi/foot, respectively. Via the Intercept method, the respective breakthrough pressures were 1,197, 1,563, 1,705, 1,791 and 1,488 psi yielding pressure graidients of 0.97, 1.48, 1.69, 182, and 1.65 psi/foot respectively. The average pressure gradients from within the entire formation (Upper, Middle and Lower Abrigo) from the five tests within this borehole were 1.79 psi/foot (Peak method) and 1.52 psi/foot (Intercept), with formation and borehole-specific averages of 1.82, 1.65, and 2.00 psi/foot for the Upper, Middle, and Lower Abrigo formations, respectively, using the Peak method. Formation and borehole-specific averages were 1.73, 1.58, and 0.97 psi/foot for the Upper, Middle,

and Lower Abrigo formations, respectively, using the Intercept method. Note the difference in the result between the calculations for the Lower Abrigo depending upon the method applied.

The site-wide averages for these three formations, from 14 tests within four boreholes, were 1.78, 1.69, and 2.00 psi/foot, respectively (Peak) and 1.71, 1.66, and 0.97 psi/foot using the Intercept method. Note that the pressure gradients from test #3, conducted at a depth of 1,010 feet were used for the average calculations for both the Upper and the Middle Abrigo formation.

NSM–009

Of the planned 6 total tests in this borehole, two intervals were pressure tested in NSM-009; one interval within the Middle Abrigo formation, and one from a combined Upper and Middle Abrigo formation . from 1096 to 1102 Pressure gradients ranged from a low of 1.54 psi/foot during test #2 at a depth of 1,276.7 feet bgs using the Intercept method within the Middle Abrigo formation, to 1.66 psi/foot (test #4) at a depth of 942.0 within the combined Upper and Middle Abrigo formation (both Peak and Intercept methods). The two tests had Peak formation breakthrough pressures of 2,010 and 1,560 psi respectively and Intercept pressures of 1,963, and 1,565 psi, respectively. The overall well average Peak pressure gradient from these two tests, representing the Upper, Middle and Lower Abrigo was 1.62 psi/foot, and 1.60 psi/foot using the Intercept method.

Test intervals from 935 to 942 and 1270 to 1277 feet appeared to be more permeable than the rate at which the packer straddle could be pressurized, as no apparent pressure peak and pressure rollover with corresponding increase of injected volume were observed. As such, these reported fracture gradient results should be considered minimum values with actual fracture gradients greater than those reported. No pressure test could be performed for the interval from 1096 to 1102 feet due to a compromised lower packer seal most likely associated with a hydraulically conductive rock interval.

The site-wide averages from 14 tests in the Abrigo formations in four boreholes using the Peak method were 1.85 psi/foot, and 1.74 psi/foot using the Intercept method. Therefore, the formation pressures measured from the testing in NSM-009 were lower than the site-wide formation averages.

NSM–006

Six intervals were pressure tested in NSM-006; three intervals specifically within the Upper Abrigo formation, one from the Middle Abrigo formation, one from the combined Middle and Upper Abrigo formation, and one from a combined Upper, Middle, and Lower Abrigo formation. Pressure gradients ranged from a low of 1.42 psi/foot during test #1 at a depth of 1,060 feet bgs (Intercept) within the combined Upper, Middle, and Lower Abrigo formations, to 1,580 psi and 1.98 psi/foot (test #4) at a depth of 798.0 feet bgs within the Upper Abrigo formation (Peak method). The six tests had formation breakthrough pressures of 1,580, 1,460, 1,620, 1,580, 1,485, and 1,380 psi respectively using the Peak method, yielding formation pressure gradients of 1.49, 1.56, 1.76, 1.98, 1.90, and 1.80 psi/foot, respectively. The Intercept breakthrough pressures for these six tests were 1,507, 1,546, 1,558, 1,516, 1,425 and 1,360 psi yielding intercept pressure gradients of 1.42, 1.65, 1.69, 1.90, 1.82, and 1.78 psi/foot. The Peak average pressure gradient from within the entire formation (Upper, Middle and Lower Abrigo) from the six tests within this borehole was 1.75 psi/foot. The Intercept average pressure gradient from within the entire formation (Upper, Middle and Lower Abrigo) from the six tests within this borehole was 1.71 psi/foot.

The site-wide averages from 14 tests in the Abrigo formations in four boreholes using the Peak method were 1.85 psi/foot, and 1.74 psi/foot using the Intercept method. Therefore, the formation pressures measured from the testing in NSM-006 were consistent with the site-wide formation averages. Note that the pressure gradients from test #1, conducted at a depth of 1,060 feet, and test #3 conducted at 921 feet bgs, were used for the average calculations for both the Middle and Lower Abrigo formations.

NSM–007

Six intervals were pressure tested in NSM-007, all from within the Martin formation. Pressure gradients ranged from a low of 1.15 psi/foot during test #6 at a depth of 660 feet bgs using the Intercept method, to 1.67 psi/foot (test #1) using the Peak method at a depth of 1,070 feet bgs.

The six tests had Peak breakthrough pressures of 1,790, 1,560, 1,355, 1,180, 1,110, and 885 psi, yielding pressure gradients of 1.67, 1.50, 1.65, 1.51, 1.51, and 1.34, respectively. The breakthrough pressures using the slope intercept method were slightly lower at 1,752, 1,492, 1,337, 1,134, 1,093, and 757 psi, yielding pressure gradients of 1.64, 1.43, 1.62, 1.45, 1.49, and 1.15, respectively. The Martin formation average pressure gradient project-wide using the Peak method (total of ten tests from within three boreholes) was 1.55 psi/foot; using the Intercept method, the Martin formation average pressure gradient was 1.46 psi/foot. From within NSM-007 only, the Peak average Martin formation pressure gradient was 1.53 psi/foot.

NSD–037

Three intervals were pressure tested in NSD-037: two intervals within the Martin formation, and one within the Middle Abrigo formation. Pressure gradients ranged from a low of 1.34 psi/foot using the intercept method during test #3 at a depth of 705 feet bgs within the Martin formation, to 2.22 (test #1) at a depth of 747 bgs within the Middle Abrigo formation using the Peak (the highest pressure gradient measured during this field effort).

The single interval measured in the Middle Abrigo formation, (test # 1) was conducted at a depth of 747 feet bgs. This test had a Peak breakthrough pressure of 1,660 psi yielding a pressure gradient of 2.22 psi/foot and had Intercept breakthrough pressure of 1,590 psi, yielding a gradient of 2.13 psi/foot. The formation average pressure gradient project-wide for the Middle Abrigo formation from eight tests in four boreholes was 1.69 psi/ft (Peak) and was 1.66 psi/foot (Intercept). Therefore, it appears that this single test from within the Middle Abrigo formation is not representative of the sitewide, formation-specific pressure gradients. Furthermore, this single test suggested a Peak pressure gradient 0.22 psi/foot higher than the second highest gradient measured at the site (2.01 psi/foot from test #1 in borehole NSM-008 within the Lower Abrigo formation). Also, this single test suggested an Intercept gradient 0.48 psi/foot higher than the second highest slope intercept gradient (1.65 psi/foot from test #2 in borehole NSM-006) from within the Middle Abrigo formation.

Two tests (test #s 2 and 3) were conducted within the Martin formation at depths of 726.7 and 705 feet bgs, respectively. These two tests had Peak breakthrough pressures of 1,370 and 1,225 psi, yielding pressure gradients of 1.89 and 1.74, respectively. These two tests had Intercept breakthrough pressures of 1,353 and 944 psi, yielding pressure gradients of 1.86 and 1.34 psi/foot respectively. The Martin formation average pressure gradients project-wide (total of ten tests from within three boreholes) were 1.55 psi/ft (Peak) and 1.42 psi/foot (Intercept); therefore these results in NSD-037 were greater than the site-wide average.

The overall NSD-037 well pressure gradient average, using the Peak method was 1.95 psi/foot and 1.78 psi/foot using the Intercept method. The formation pressures measured from the testing within NSD-037 were higher than the site-wide formation averages.

Conclusions

Based on the interval-specific pressure data collected during this field effort from 29 packer pressure tests, representing 31 calculated pressure gradients from six formations, the following conclusions are made. Note that in both tables, test intervals that included two or more geologic units were counted separately for each unit.

In general, the pressure gradients from the Intercept method were slightly less than those calculated using the Peak Pressure method. The site-wide average pressure gradients were 1.67 psi/foot and 1.55 psi/foot using the Peak, and slope intercept methods, respectively. The minimum pressure gradient was 0.78 psi/foot (Intercept method in test #4 in borehole NSD-043 within the Escabrosa formation) and the maximum pressure gradient was 2.22 psi/foot (Peak in test #1 in borehole NSD-037 within the Middle Abrigo formation). The total pressure gradient range was 1.29 psi/foot using the Peak method and was 1.35 using the Intercept method.

Peak method formation-specific pressure gradients ranged from 1.30 psi/foot conducted in borehole NSD043 within the Escabrosa formation, to 2.00 psi/foot in the Lower Abrigo formation (test #1 in borehole NSM-008. Intercept method formation specific pressure gradient ranges were from 1.20 psi/foot in borehole NSD-043 within the Escabrosa formation, to 2.13 psi/foot in the Middle Abrigo formation (test #1) from within borehole NSD-037. The Escabrosa Formation appears to be the weakest of the rocks at the Gunnison site. Injection pressures should be kept below 1.2 psi/foot, the average pressure gradient for the Escabrosa Formation, to prevent alteration of fracture permeabilities.

References

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6. “Determination of Fracture Parameters from Fracturing Pressure Decline", Nolte, K. G., Paper SPE 8341, Presented at the Annual Technical Conference and Exhibition, Las Vegas, NV, Sept. 23-26, 1979.

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TABLES

Table A - Formation Fracture Pressure Gradient, Excelsior Gunnison Copper Project (Peak Pressure Method)

Borehole Information							Formation (psi/foot)						
Borehole	Borehole Diameter (inches)	Test Date	Test Number	Test Interval Depth (ft bls)	Bit Depth (ft bls)	Estimated Fracture Pressure (psi)	Horquilla	Escabrosa	Martin	Upper Abrigo	Middle Abrigo	Lower Abrigo	Overall Well Average
NSD-043	4	21-Jun-15	1b	1,504.5	1,485.5	1,925			1.28				1.38
		22-Jun-15	2	1,445.0	1,426.0	2,000			1.38				
		22-Jun-15	3a	1,404.5	1,385.6	1,380		0.98					
		22-Jun-15	3b	1,405.5	1,386.6	1,305		0.93					
		22-Jun-15	4	1,170.0	1,154.5	2,325		1.99					
		23-Jun-15	5	996.5	981.0	1,695	1.70						
NSM-008	4.75	24-Jun-15	1	1,239.5	1,224.0	2,485						2.00	1.79
		24-Jun-15	2	1,054.6	1,039.0	1,585					1.50		
		24-Jun-15	3	1,010.0	994.5	1,800				1.78			
		24-Jun-15	4	986.5	971.0	1,865				1.89			
		25-Jun-15	5	901.7	886.0	1,580				1.75			
NSM-009	5.15	26-Jun-15	2	1,276.7	1,261.0	2,010					1.57		1.62
		27-Jun-15	3	1,102.0	1,086.5	1,585				No Test			
		27-Jun-15	4	942.0	926.5	1,560				1.66			
NSM-006	3.75	28-Jun-15	1	1,060.0	1,044.6	1,580				1.49			1.75
		28-Jun-15	2	937.0	921.5	1,460					1.56		
		28-Jun-15	3	921.0	905.5	1,620				1.76			
		29-Jun-15	4	798.0	782.5	1,580				1.98			
		29-Jun-15	5	782.6	767.0	1,485				1.90			
		29-Jun-15	6	766.0	750.5	1,380				1.80			
NSM-007	3.75	30-Jun-15	1	1,070.0	1,054.5	1,790			1.67				1.53
		30-Jun-15	2	1,039.7	1,024.0	1,560			1.50				
		30-Jun-15	3	823.7	808.0	1,355			1.65				
		30-Jun-15	4	781.5	766.0	1,180			1.51				
		30-Jun-15	5	734.0	718.5	1,110			1.51				
		30-Jun-15	6	660.7	645.0	885			1.34				
NSD-037	3.75	2-Jul-15	1	747.0	-	1,660					2.22		1.95
		2-Jul-15	2	726.7	-	1,370			1.89				
		2-Jul-15	3	705.0	-	1,225			1.74				
Formation Average Fracture Gradient							**1.70**	**1.30**	**1.55**	**1.78**	**1.69**	**1.75**	**1.67**
Number of Tests per Formation							**1**	**3**	**10**	**9**	**8**	**1**	

Notes:
ft - feet
bls = below land surface
psi = pounds per square inch
formation fracture pressure gradient - estimated breakthrough pressure / depth of bottom of packed interval in ft bls

Table B - Formation Fracture Pressure Gradient, Excelsior Gunnison Copper Project (Q vs P Intercept Method)

Borehole Information							Formation (psi/foot)						
Borehole	Borehole Diameter (inches)	Test Date	Test Number	Test Interval Depth (ft bls)	Bit Depth (ft bls)	Estimated Fracture Pressure (psi)	Horquilla	Escabrosa	Martin	Upper Abrigo	Middle Abrigo	Lower Abrigo	Overall Well Average
NSD-043	4	21-Jun-15	1b	1,504.5	1,485.5	1,563			1.04				1.21
		22-Jun-15	2	1,445.0	1,426.0	1,712			1.18				
		22-Jun-15	3a	1,404.5	1,385.6	1,090		0.78					
		22-Jun-15	3b	1,405.5	1,386.6	1,310		0.93					
		22-Jun-15	4	1,170.0	1,154.5	2,199		1.88					
		23-Jun-15	5	996.5	981.0	1,454	1.46						
NSM-008	4.75	24-Jun-15	1	1,239.5	1,224.0	1,197						0.97	1.52
		24-Jun-15	2	1,054.6	1,039.0	1,563					1.48		
		24-Jun-15	3	1,010.0	994.5	1,705				1.69			
		24-Jun-15	4	986.5	971.0	1,791				1.82			
		25-Jun-15	5	901.7	886.0	1,488				1.65			
NSM-009	5.15	26-Jun-15	2	1,276.7	1,261.0	1,963					1.54		1.60
		27-Jun-15	3	1,102.0	1,086.5	1,585				No Test			
		27-Jun-15	4	942.0	926.5	1,565				1.66			
NSM-006	3.75	28-Jun-15	1	1,060.0	1,044.6	1,507				1.42			1.71
		28-Jun-15	2	937.0	921.5	1,546					1.65		
		28-Jun-15	3	921.0	905.5	1,558				1.69			
		29-Jun-15	4	798.0	782.5	1,516				1.90			
		29-Jun-15	5	782.6	767.0	1,425				1.82			
		29-Jun-15	6	766.0	750.5	1,360				1.78			
NSM-007	3.75	30-Jun-15	1	1,070.0	1,054.5	1,752			1.64				1.46
		30-Jun-15	2	1,039.7	1,024.0	1,492			1.43				
		30-Jun-15	3	823.7	808.0	1,337			1.62				
		30-Jun-15	4	781.5	766.0	1,134			1.45				
		30-Jun-15	5	734.0	718.5	1,093			1.49				
		30-Jun-15	6	660.7	645.0	757			1.15				
NSD-037	3.75	2-Jul-15	1	747.0	-	1,590					2.13		1.78
		2-Jul-15	2	726.7	-	1,353			1.86				
		2-Jul-15	3	705.0	-	944			1.34				
Formation Average Fracture Gradient							**1.46**	**1.20**	**1.42**	**1.71**	**1.66**	**1.20**	**1.55**
Number of Tests per Formation							**1**	**3**	**10**	**9**	**8**	**2**	

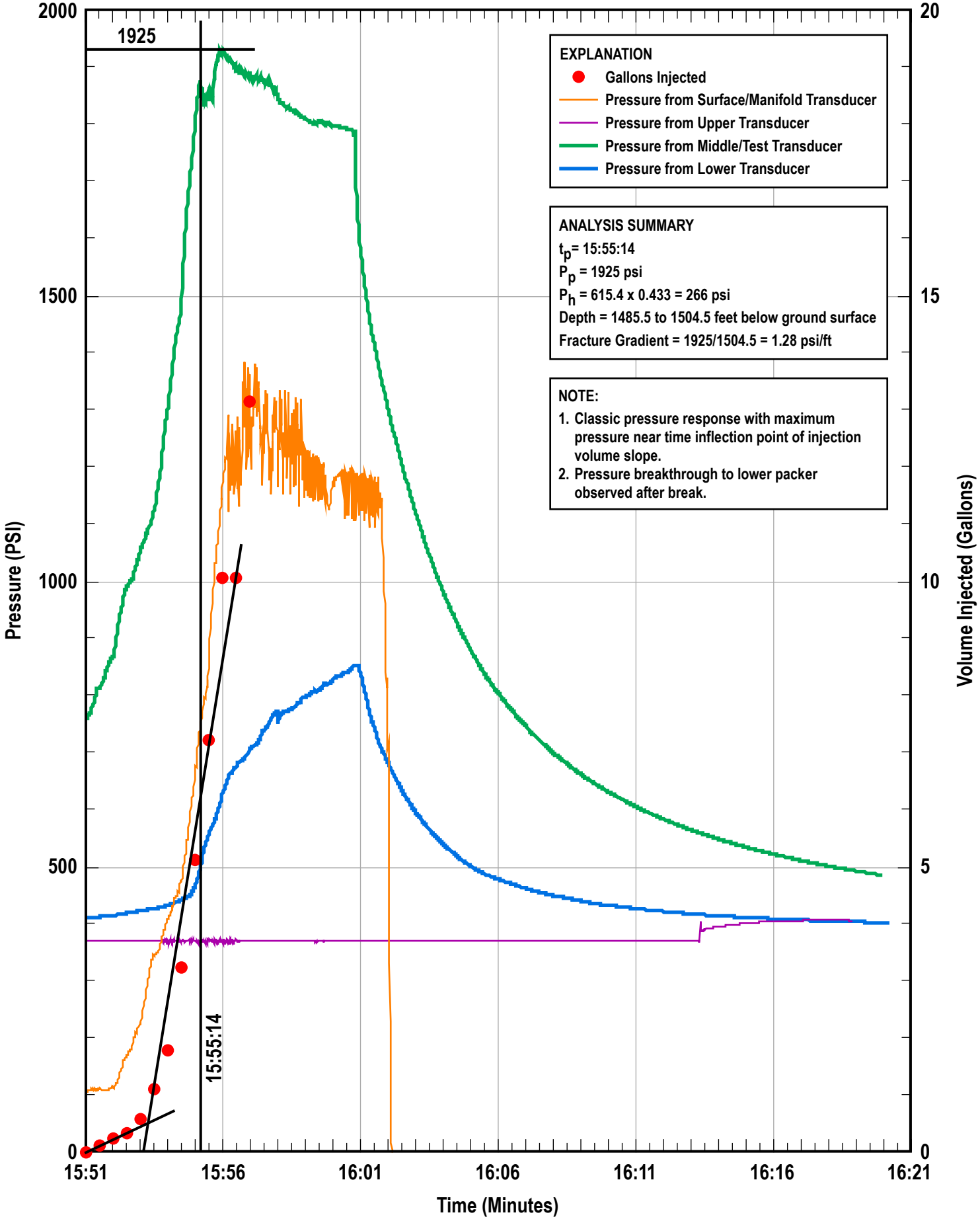
Notes:
ft - feet
bls = below land surface
psi = pounds per square inch
formation fracture pressure gradient - estimated breakthrough pressure / depth of bottom of packed interval in ft bls

APPENDIX A

EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 21, 2015 - 1551 to 1620 Hours - 1495.5 to 1504.5 feet below ground surface

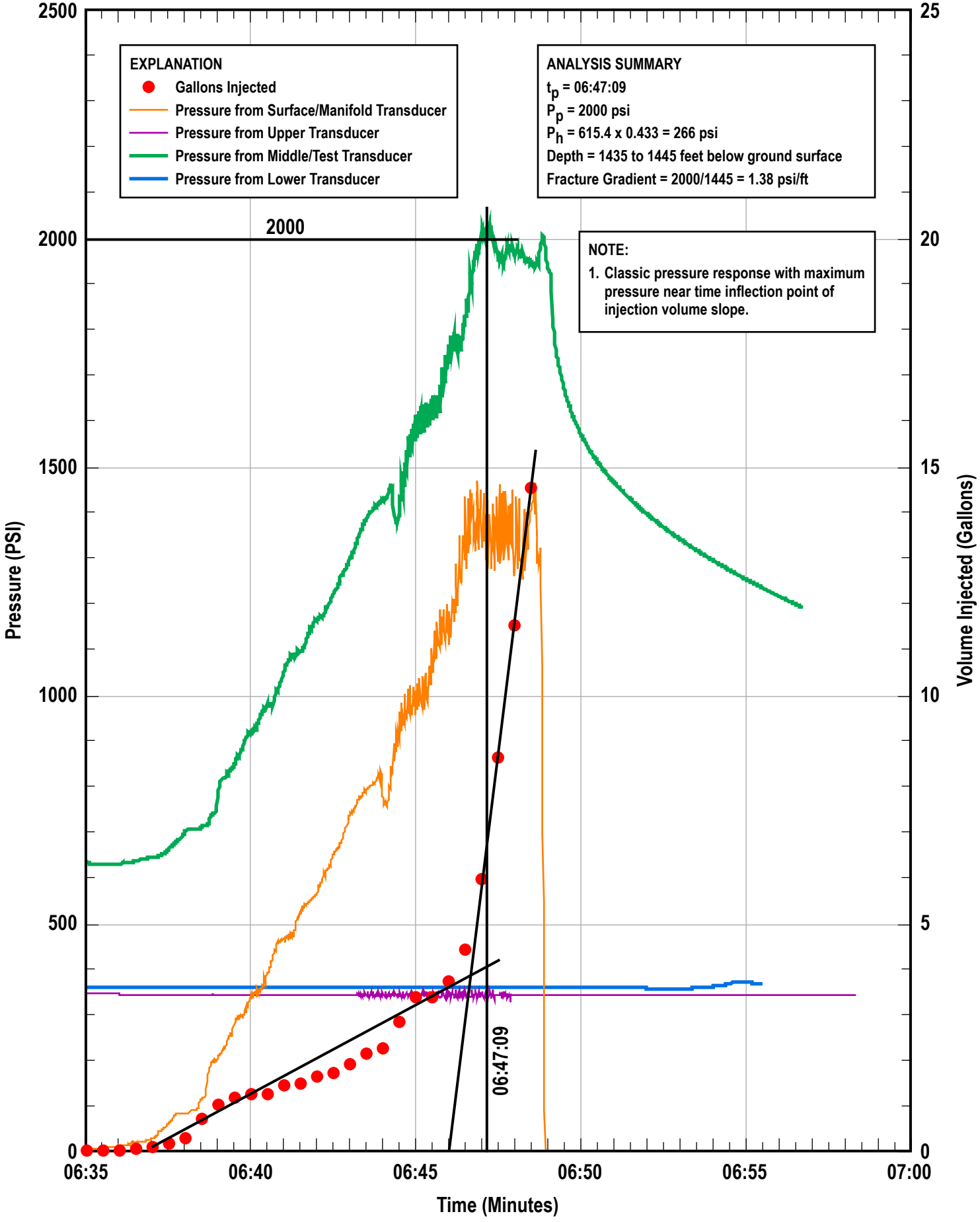
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 22, 2015 - 0635 to 0700 Hours - 1435 to 1445 feet below ground surface

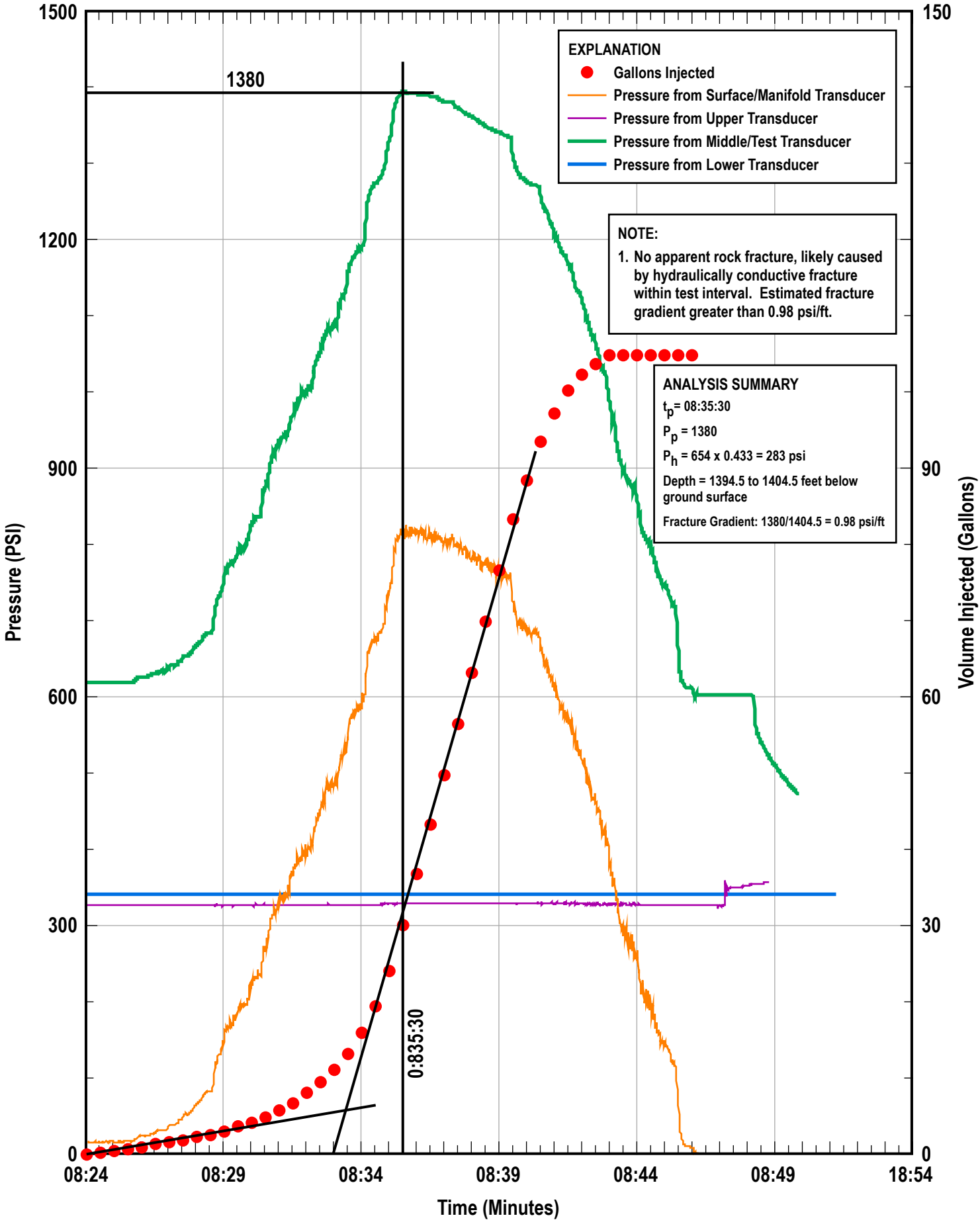
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 22, 2015 - 0824 to 0850 Hours - 1394.5 to 1404.5 feet below ground surface

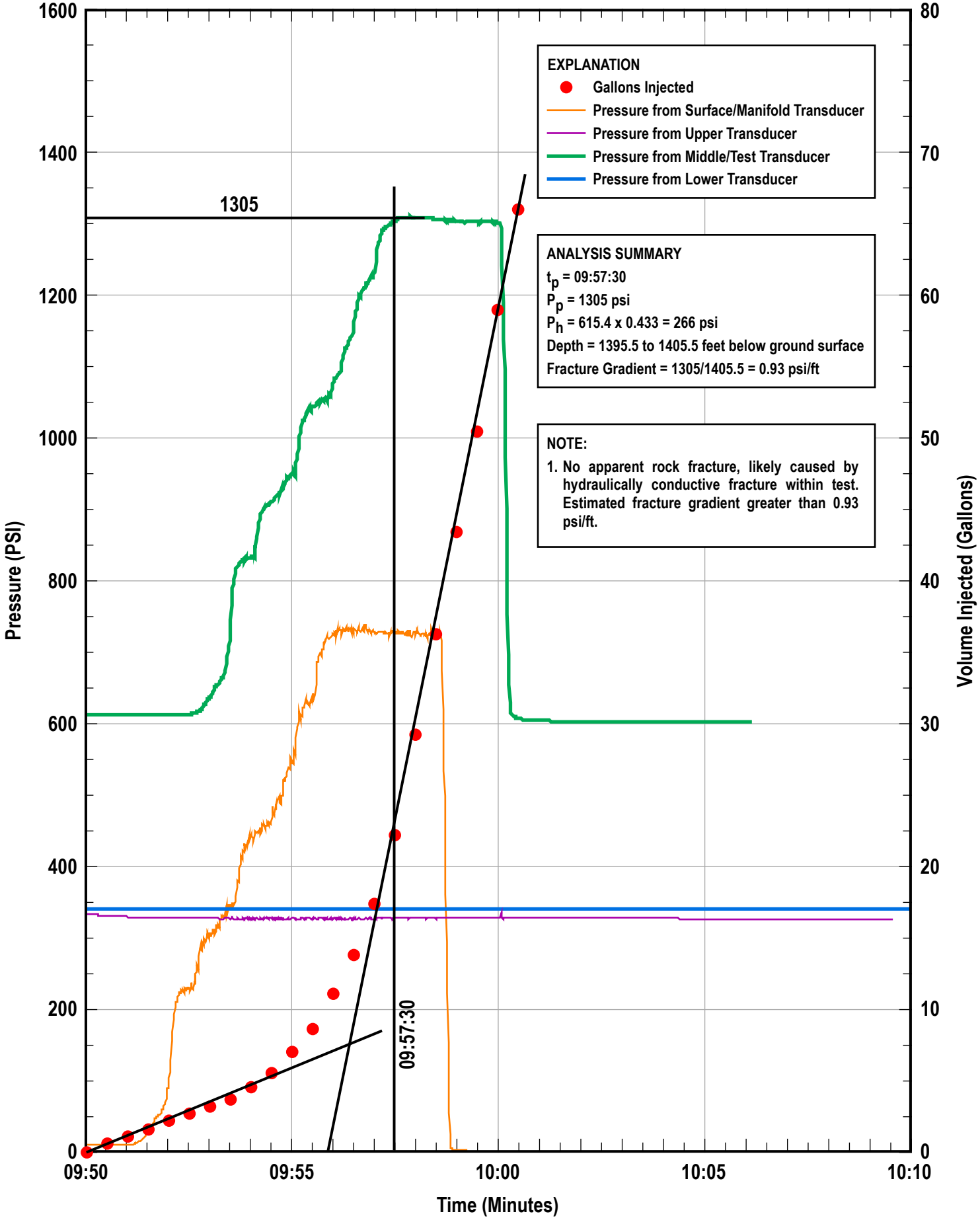
Formation Tested: Escabrosa



EXCELSIOR DRAGOON PROJECT - WELL NSD-043

June 22, 2015 - 0950 to 1010 Hours - 1395.5 to 1405.5 feet below ground surface

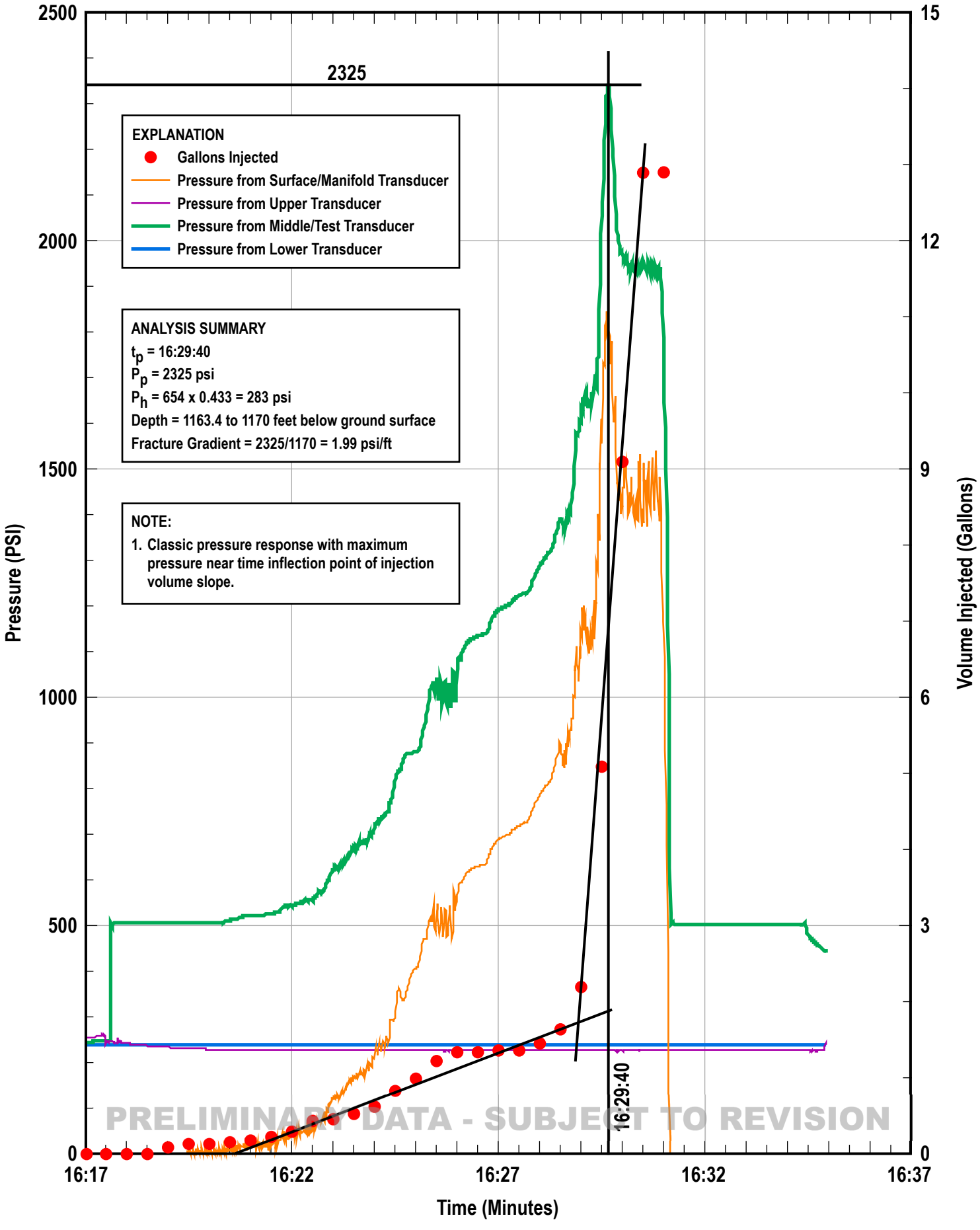
Formation Tested: Escabrosa



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 22, 2015 - 1617 to 1631 Hours - 1163.4 to 1170 feet below ground surface

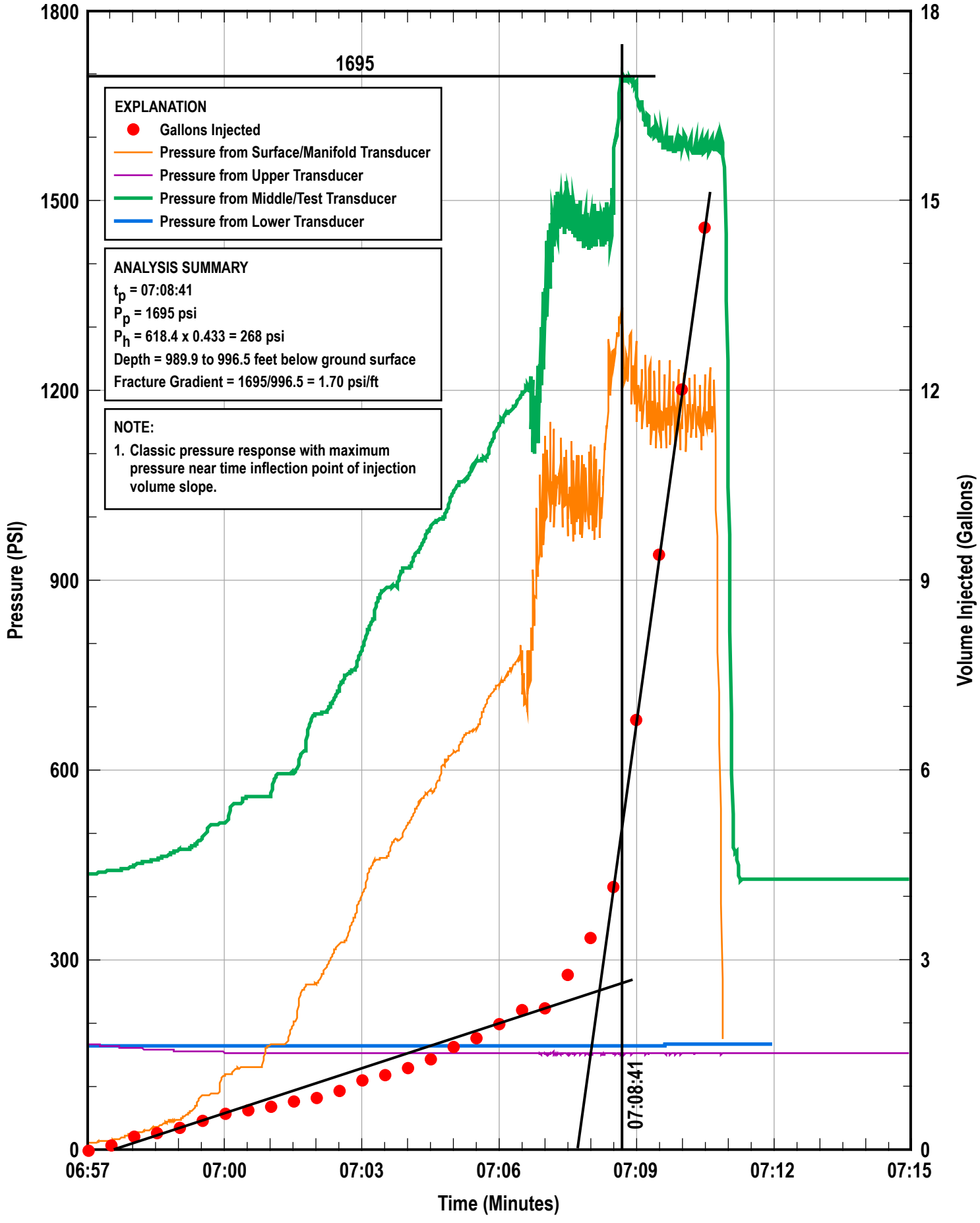
Formation Tested: Escabrosa



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 23, 2015 - 0657 to 0715 - (989.9 to 996.5 feet below ground surface)

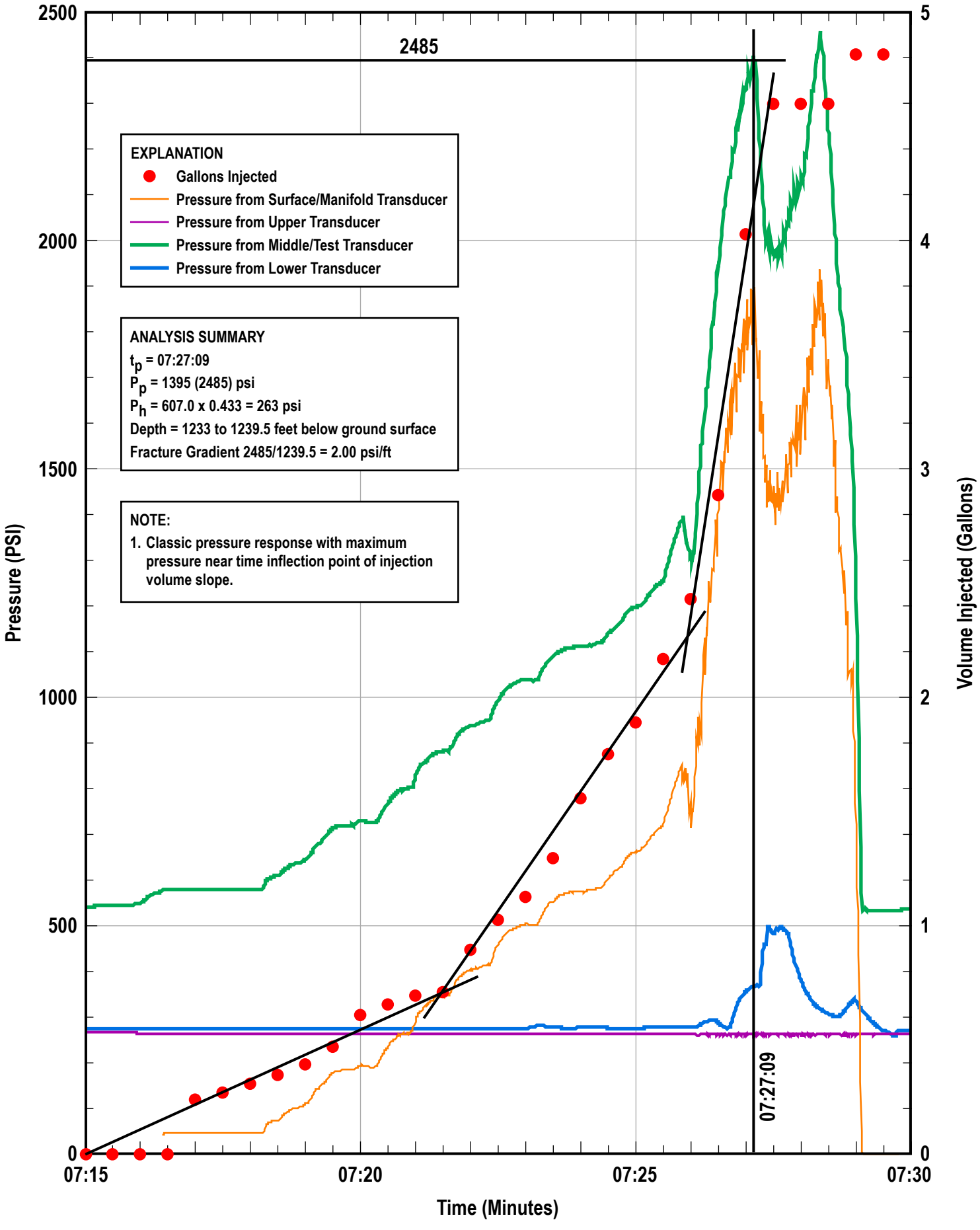
Formation Tested: Horquilla



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 0715 to 0730 Hours - 1233 to 1239.5 feet below ground surface

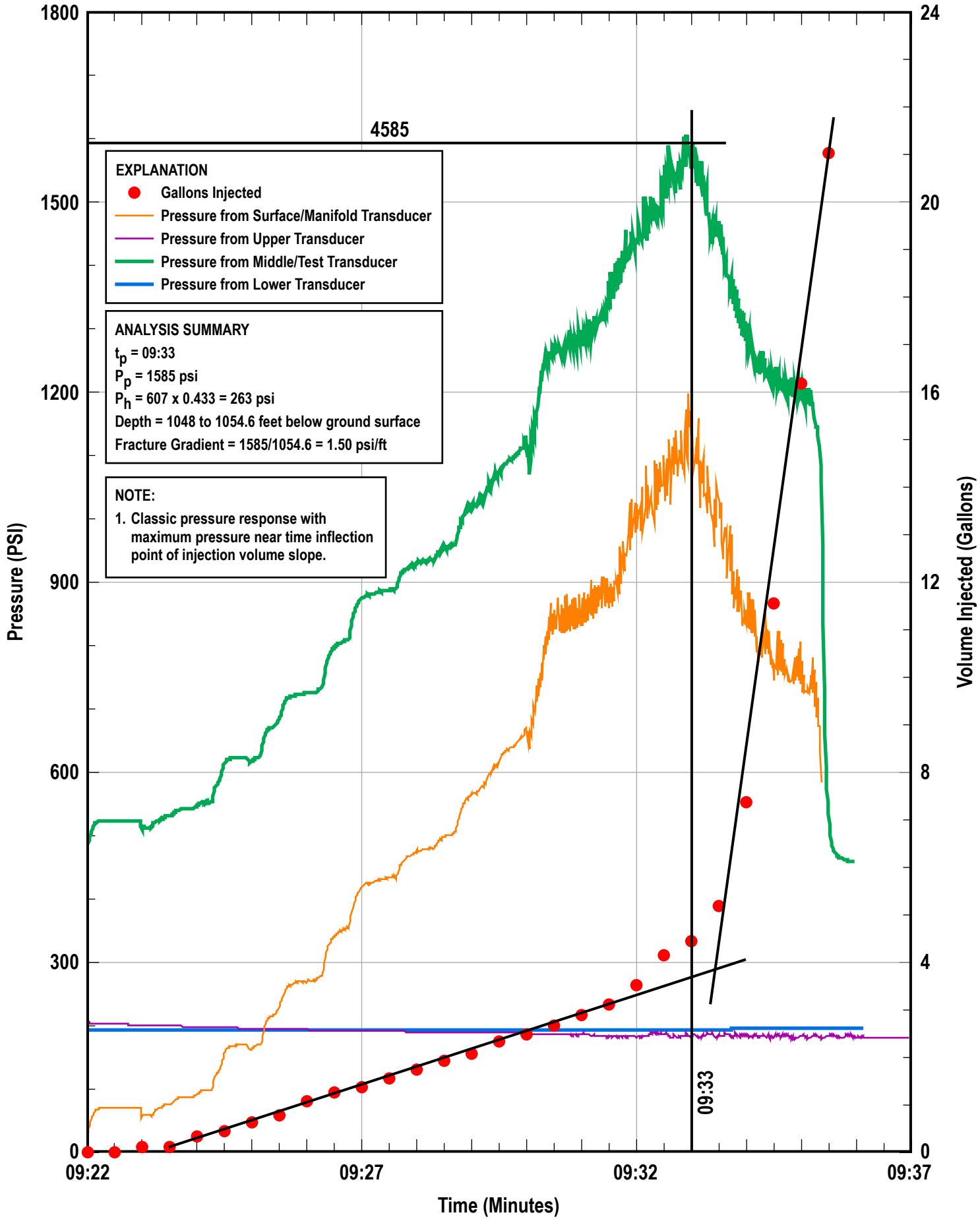
Formation Tested: Lower Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 0922 to 0936 Hours - 1048 to 1054.6 feet below ground surface

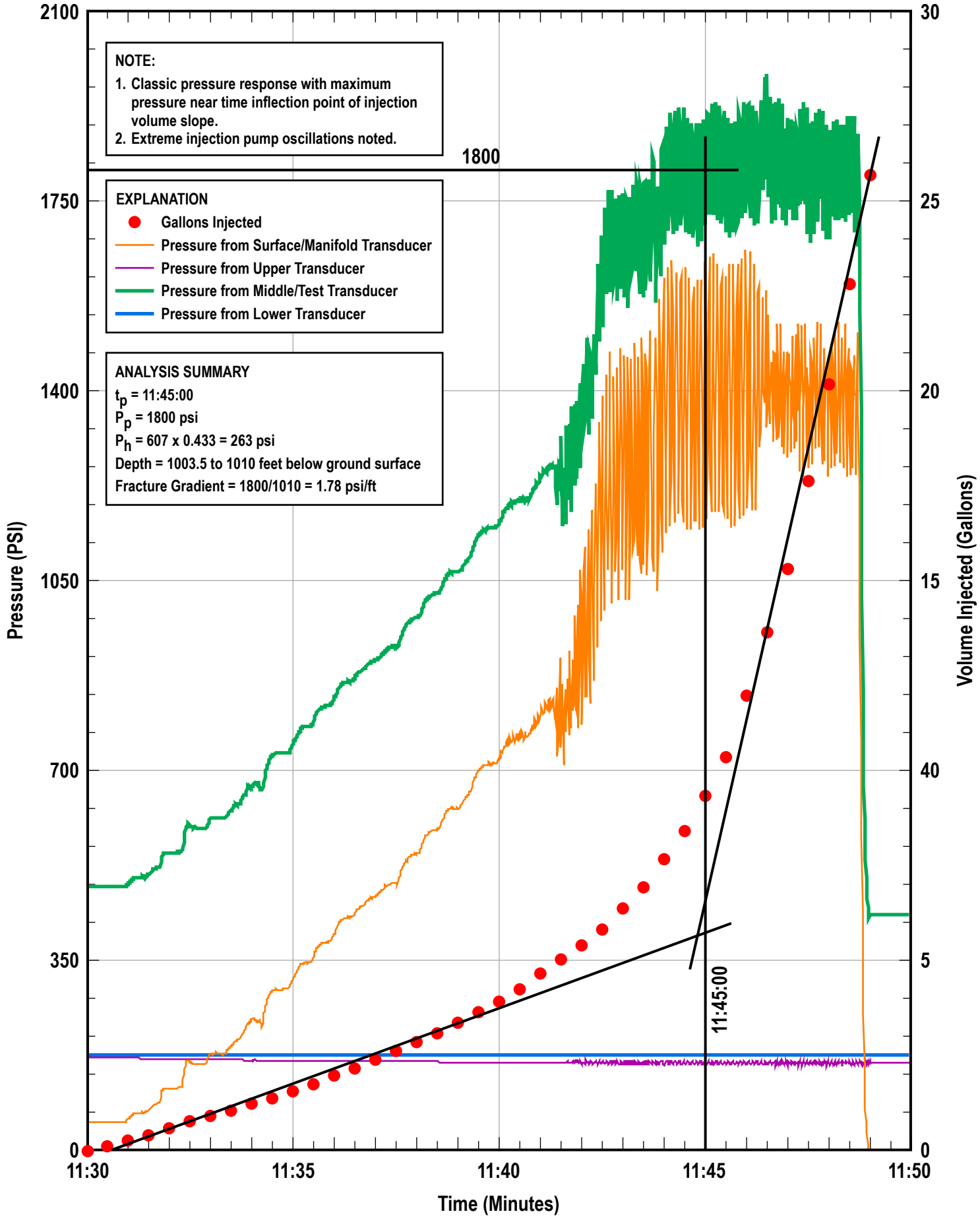
Formation Tested: Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 1130 to 1150 Hours - 1003.5 to 1010 feet below ground surface

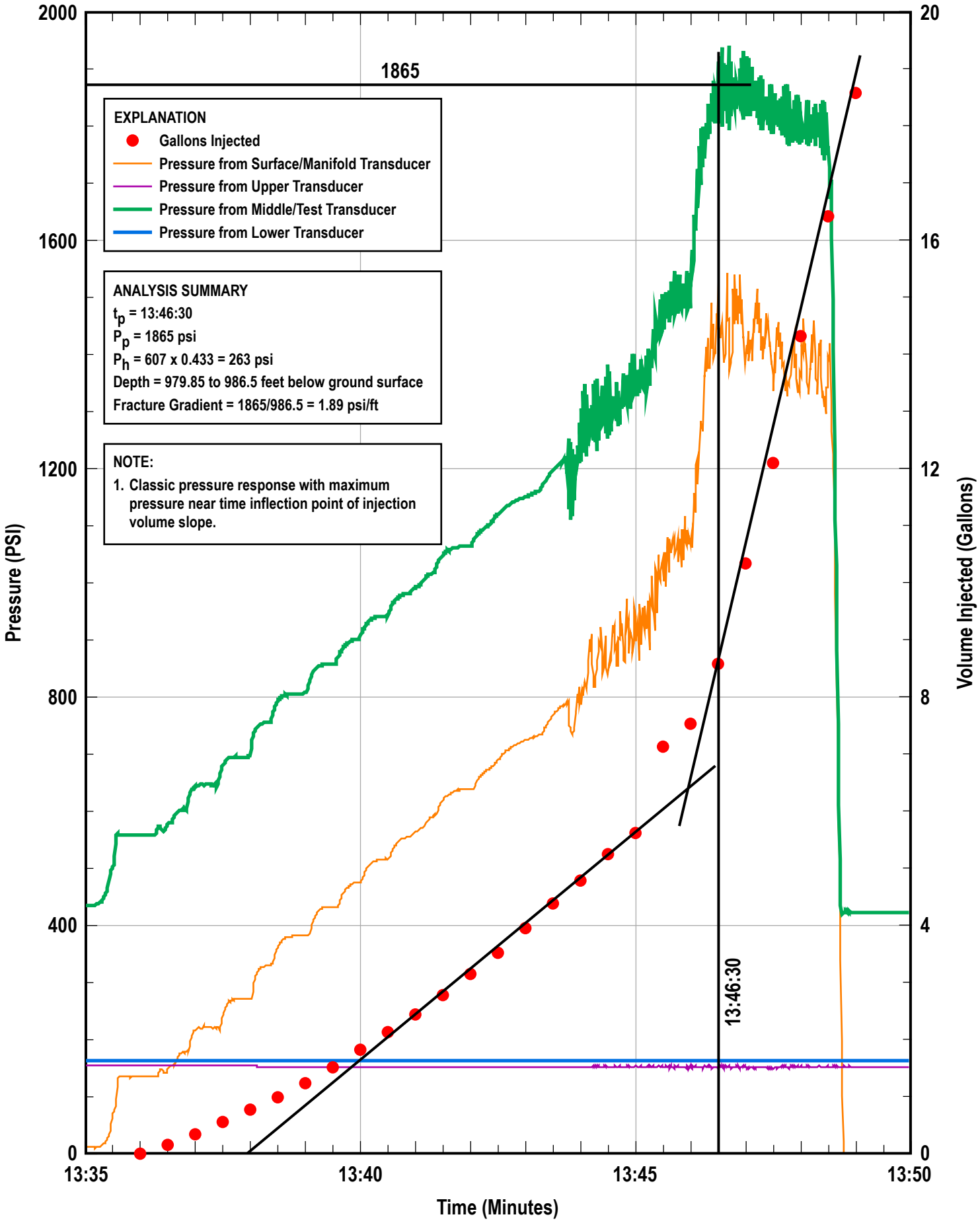
Formations Tested: Upper/Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 1335 to 1350 Hours - 979.85 to 986.5 feet below ground surface

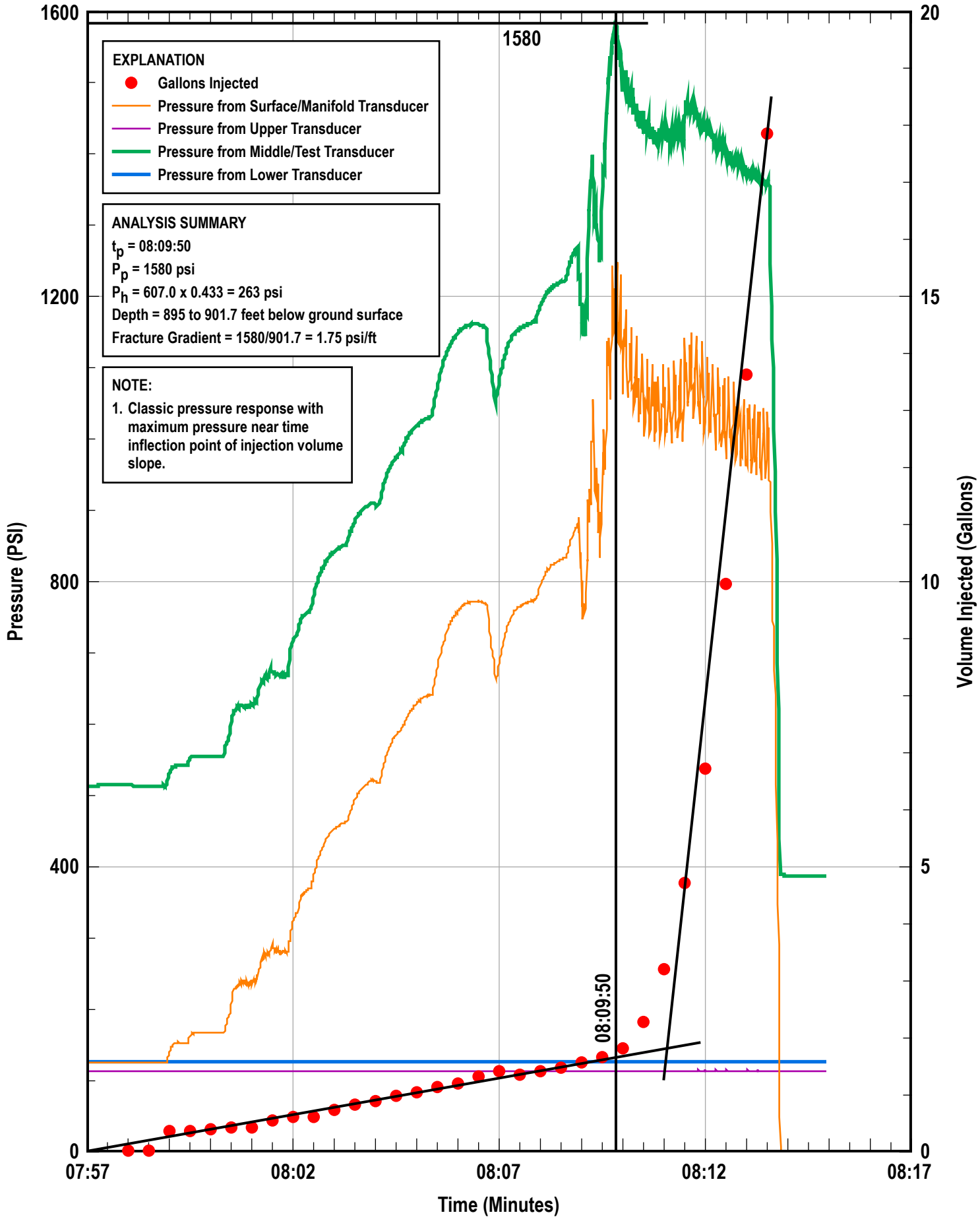
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 25, 2015 - 0757 to 0815 Hours - 895 to 901.7 feet below ground surface

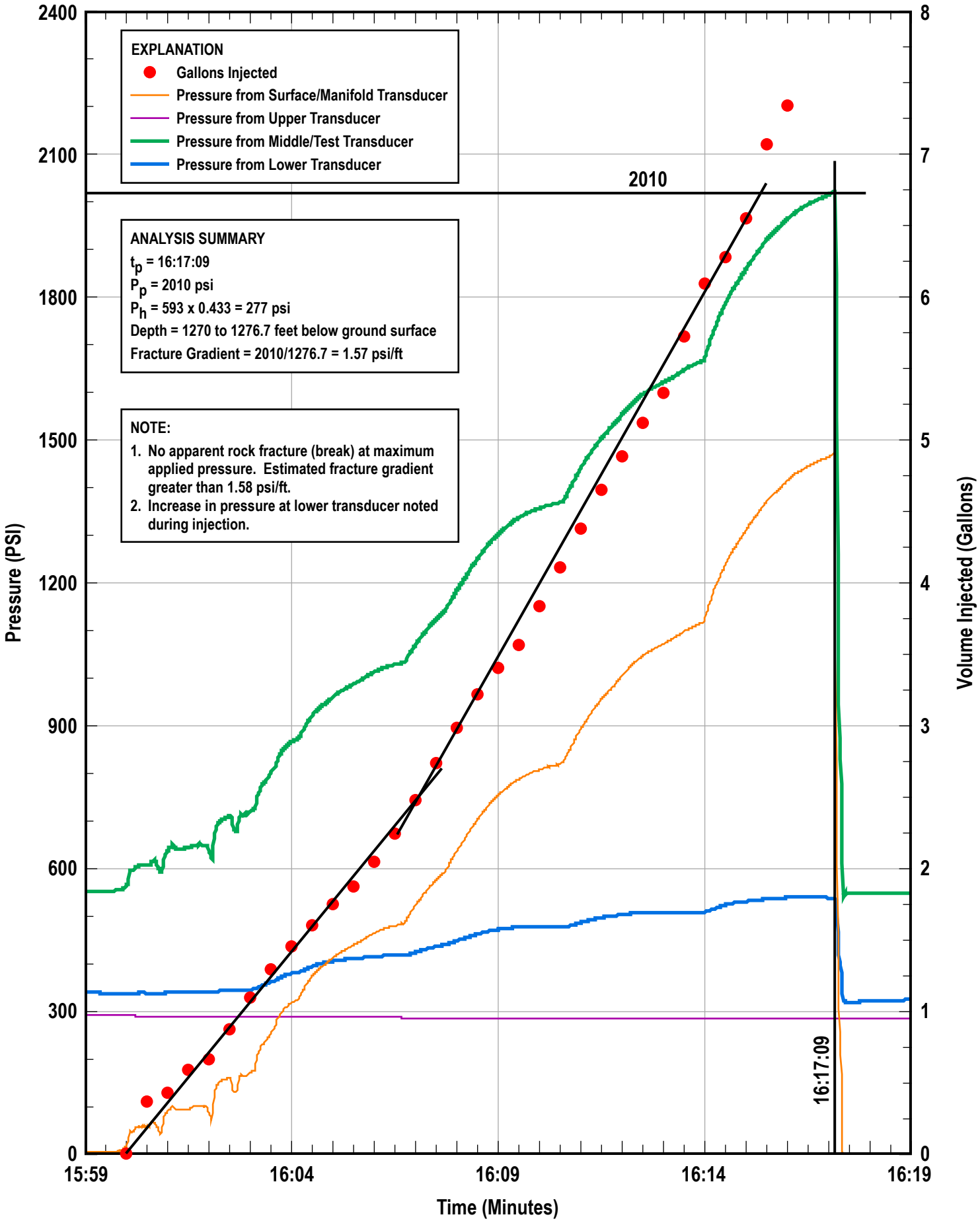
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-009

June 26, 2015 - 1559 to 1520 Hours - 1270 to 1276.7 feet below ground surface

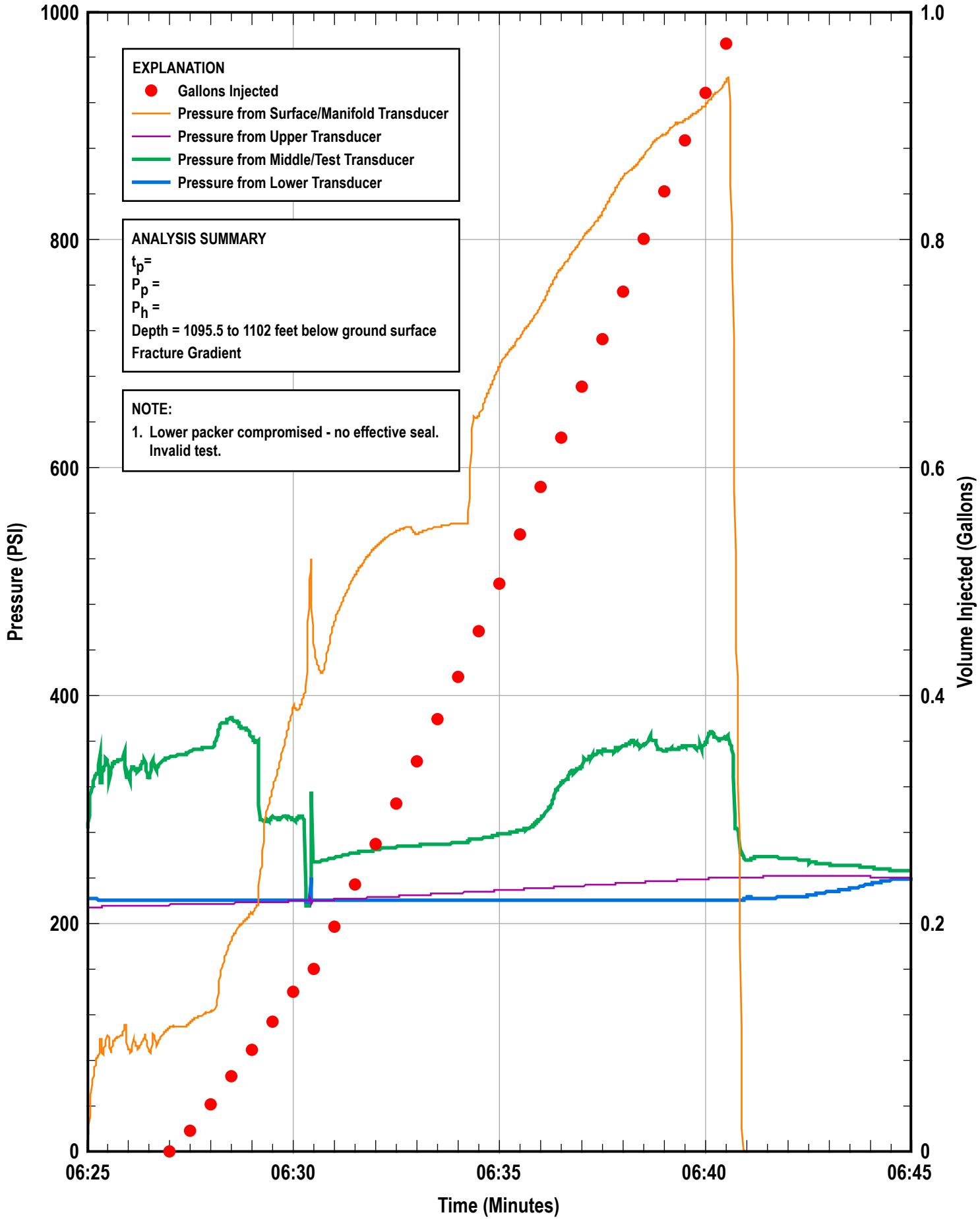
Formation Tested: Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-009

June 27, 2015 - 0625 to 0650 Hours - 1095.5 to 1102 feet below ground surface

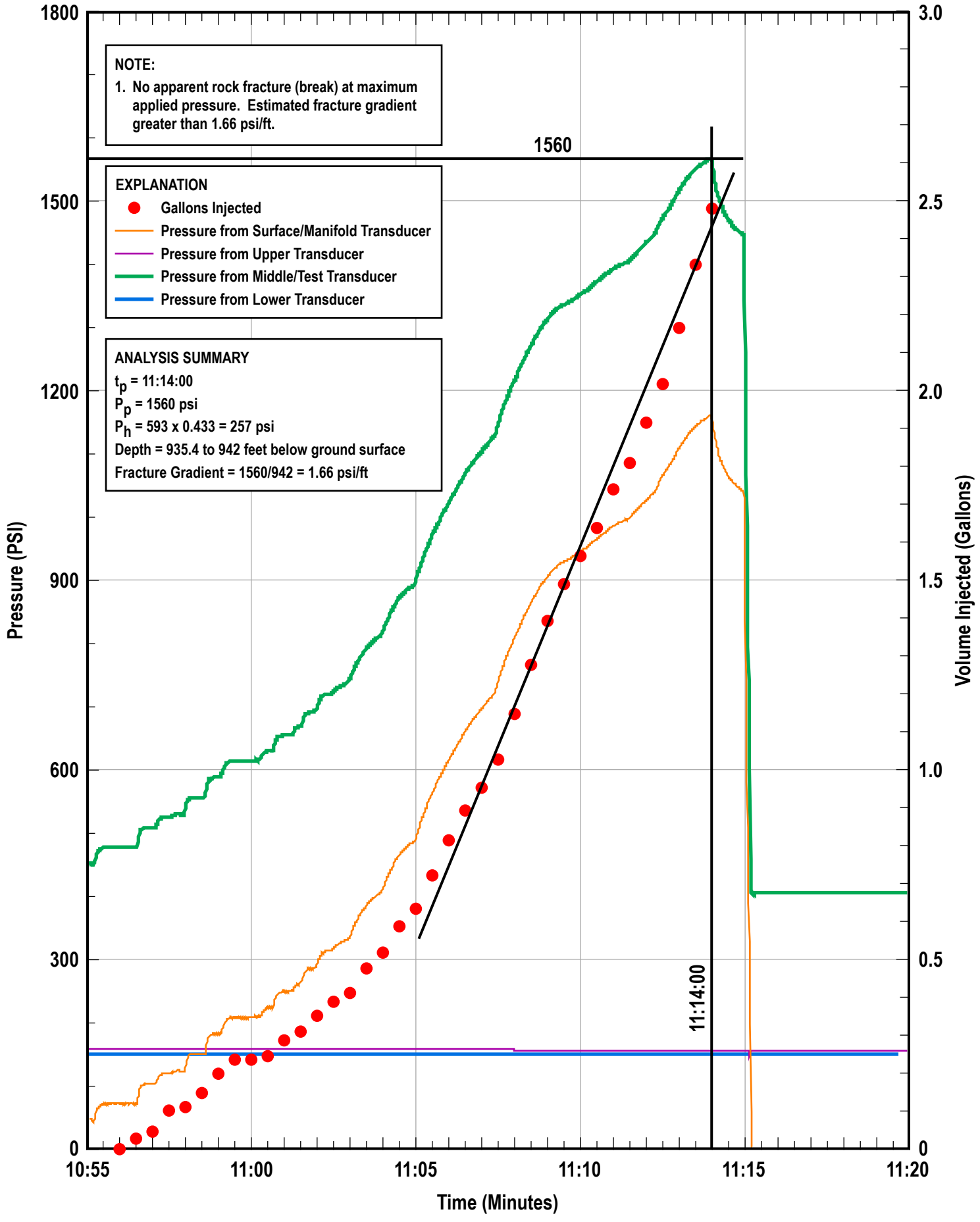
Formation Tested: No Test



EXCELSIOR GUNNISON PROJECT - WELL NSM-009

June 27, 2015 - 1055 to 1120 Hours - 935.4 to 942 feet below ground surface

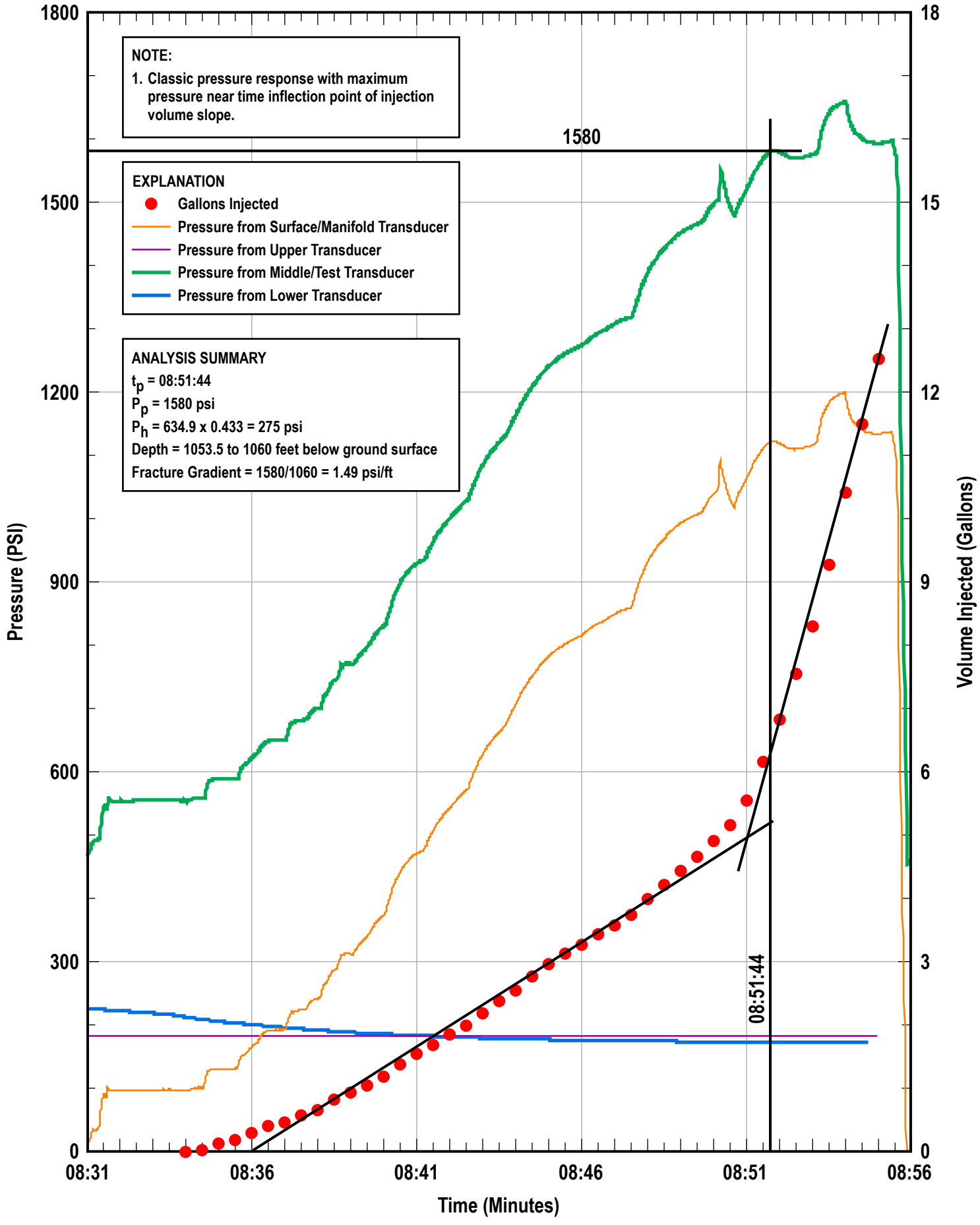
Formation Tested: Upper/Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 28, 2015 - 0831 to 0855 Hours - 1053.5 to 1060 feet below ground surface

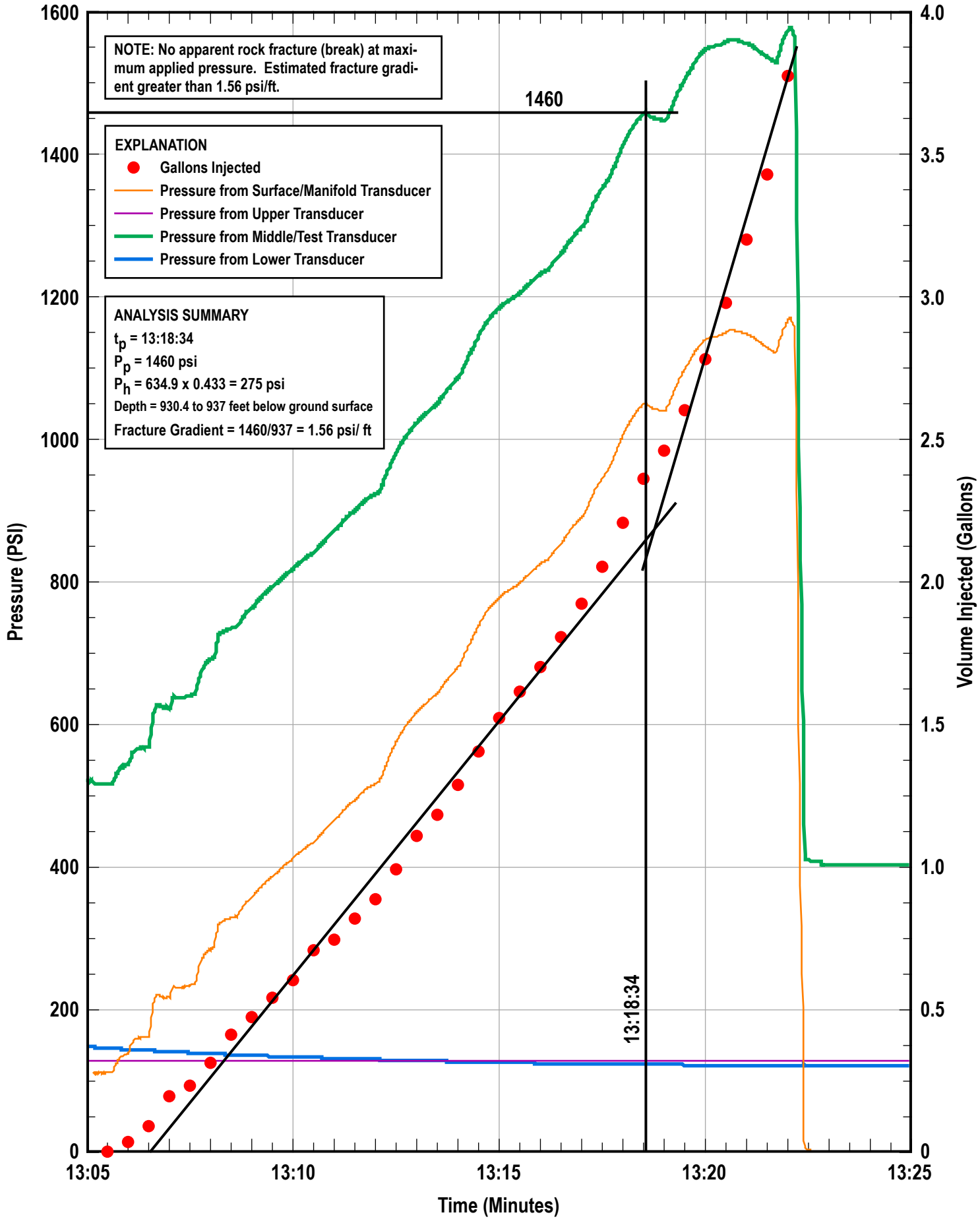
Formation Tested: Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 28, 2015 - 1305 to 1325 Hours - 930.4 to 937 feet below ground surface

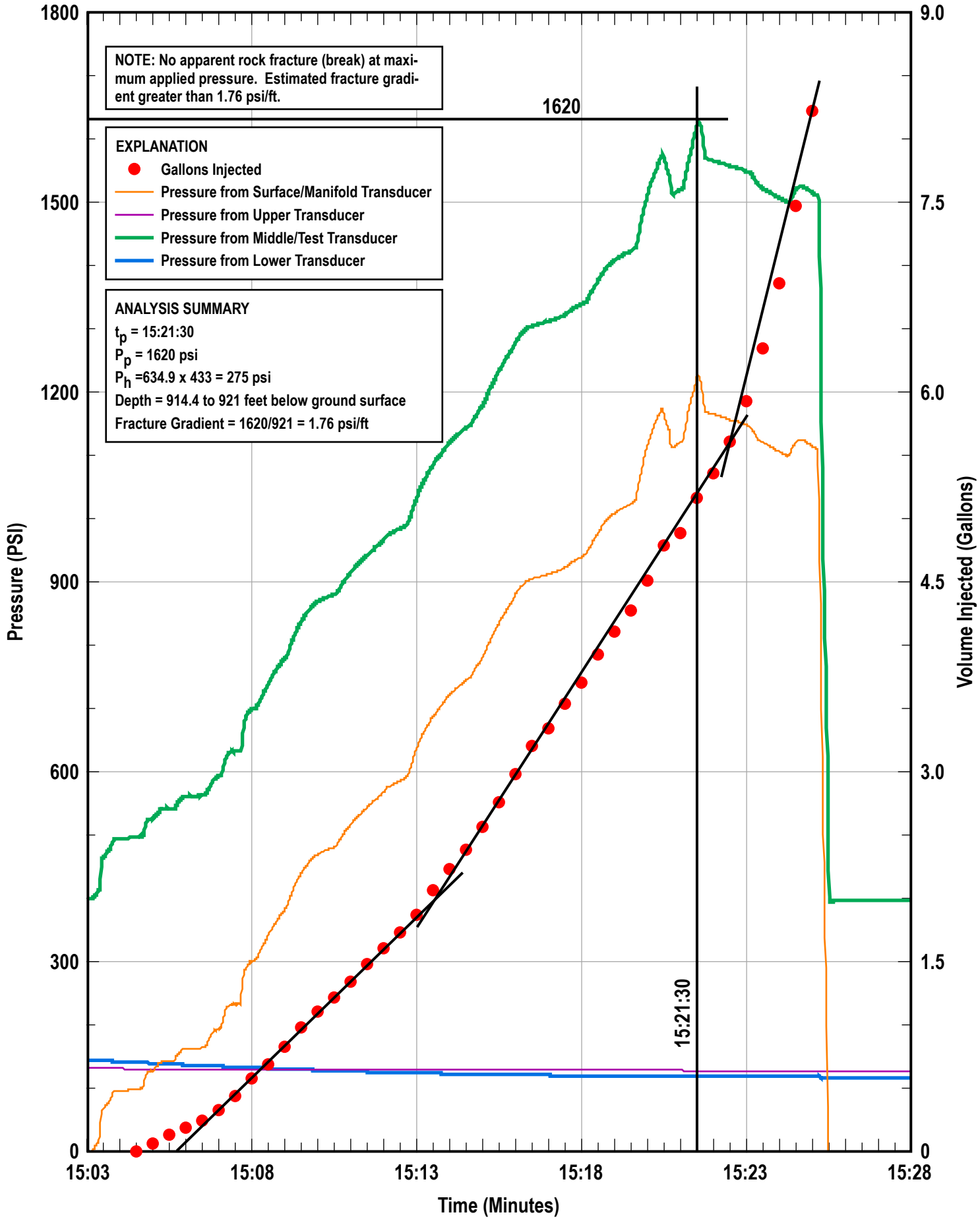
Formation Tested: Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 28, 2015 - 1503 to 1530 Hours - 914.4 to 921 feet below ground surface

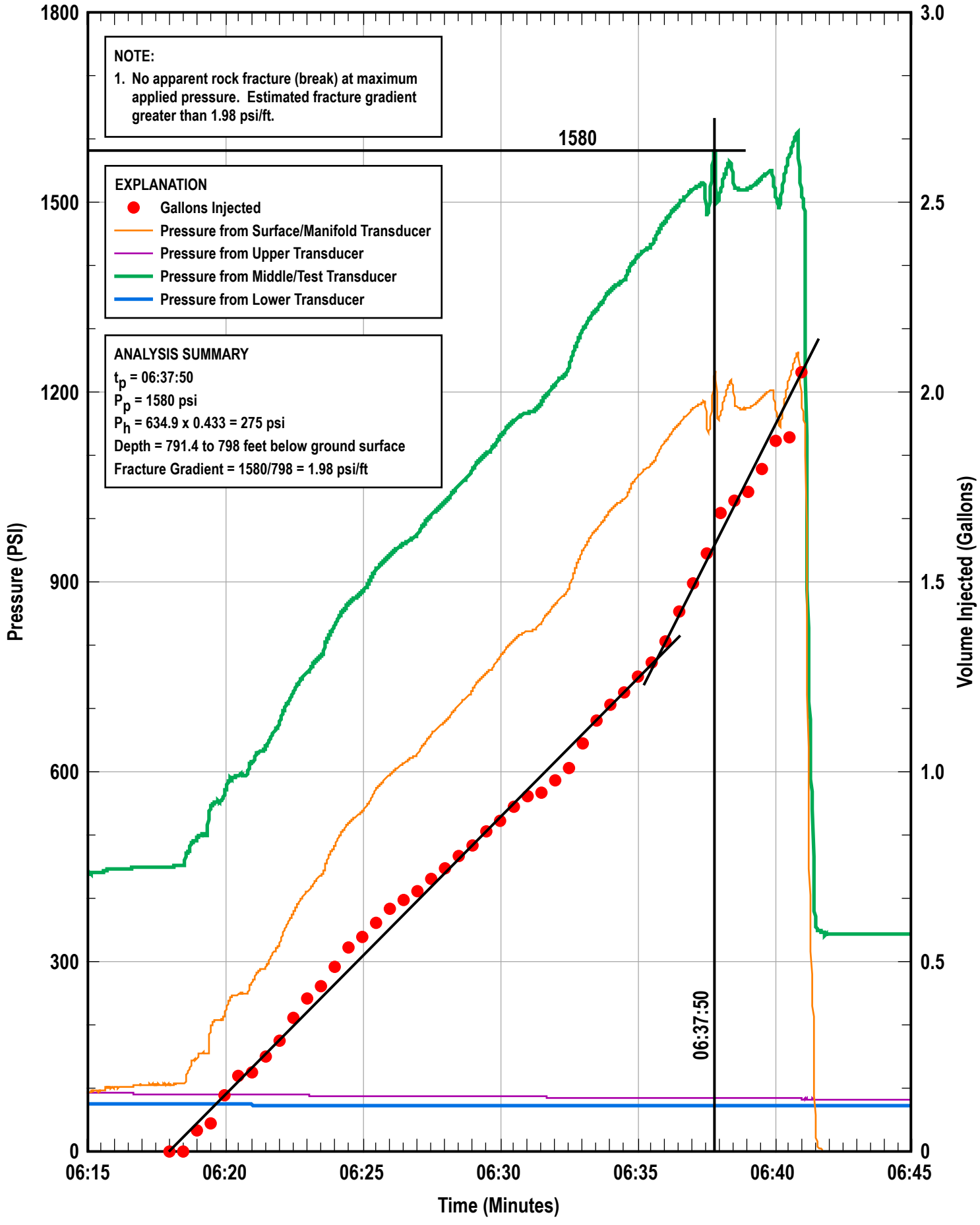
Formations Tested: Upper/Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 29, 2015 - 0615 to 0650 Hours - 791.4 to 798 feet below ground surface

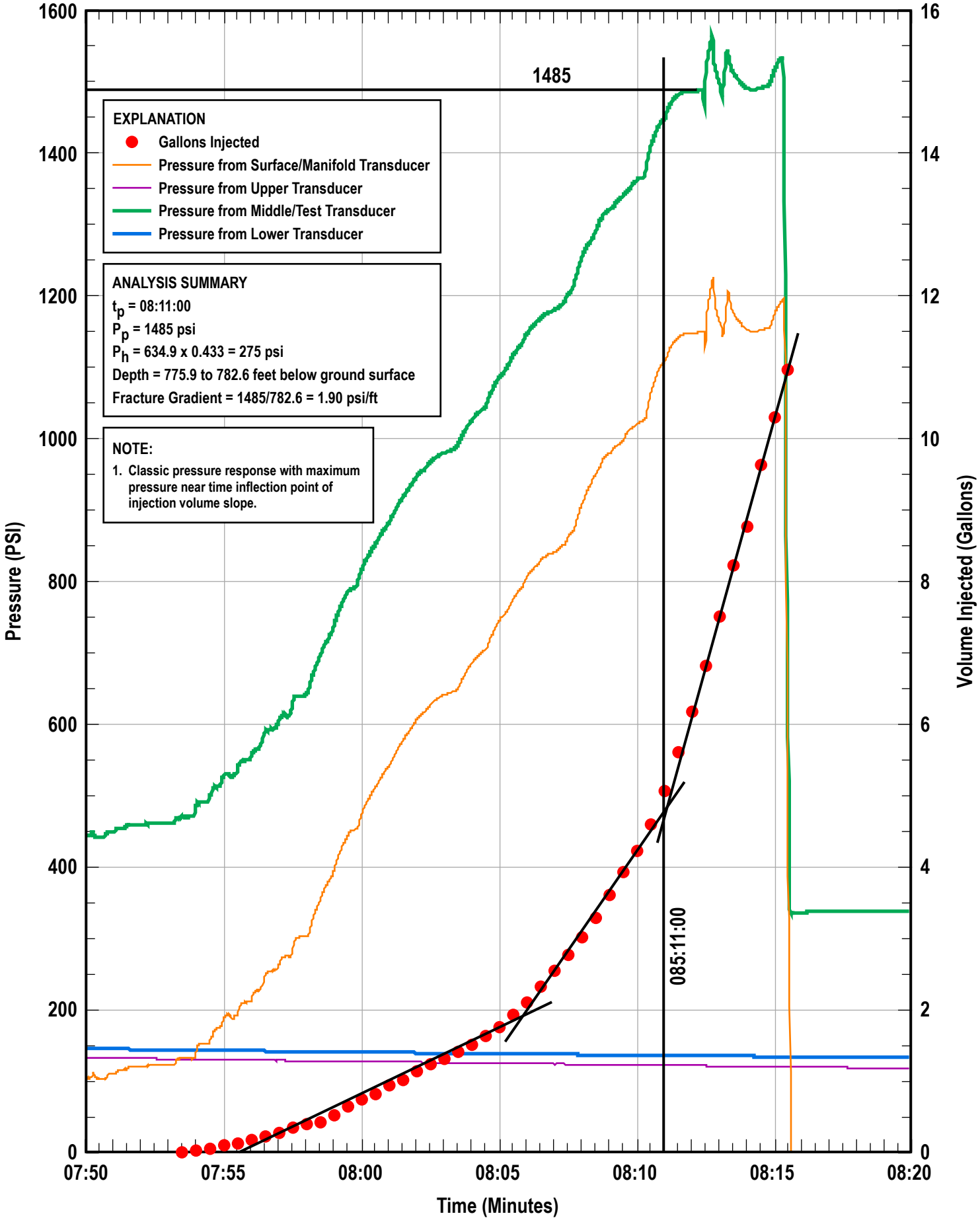
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 29, 2015 - 0750 to 0820 Hours - 775.9 to 782.6 feet below ground surface

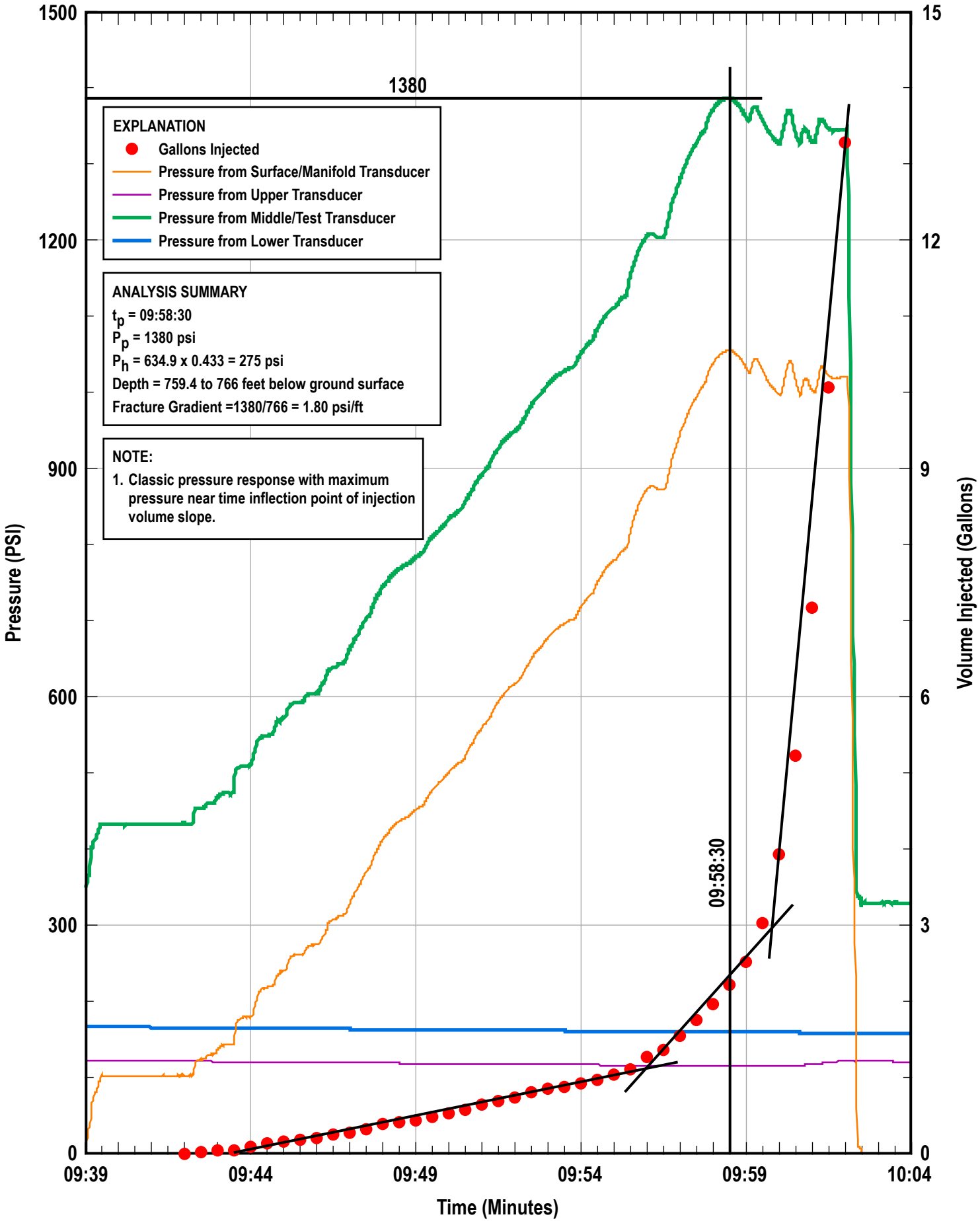
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 29, 2015 - 0939 to 1005 Hours - 759.4 to 766 feet below ground surface

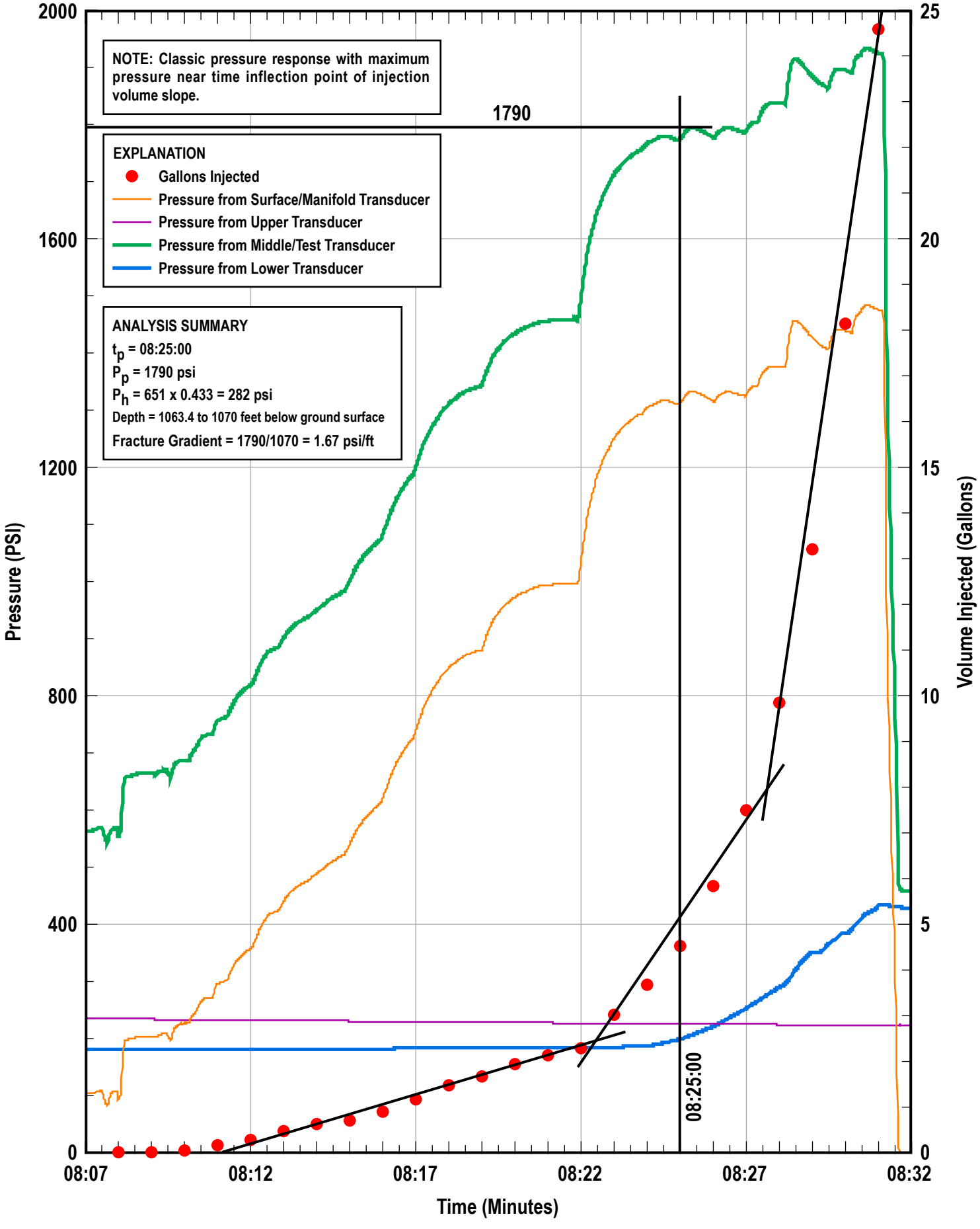
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 0808 to 0831 Hours - 1063.4 to 1070 feet below ground surface

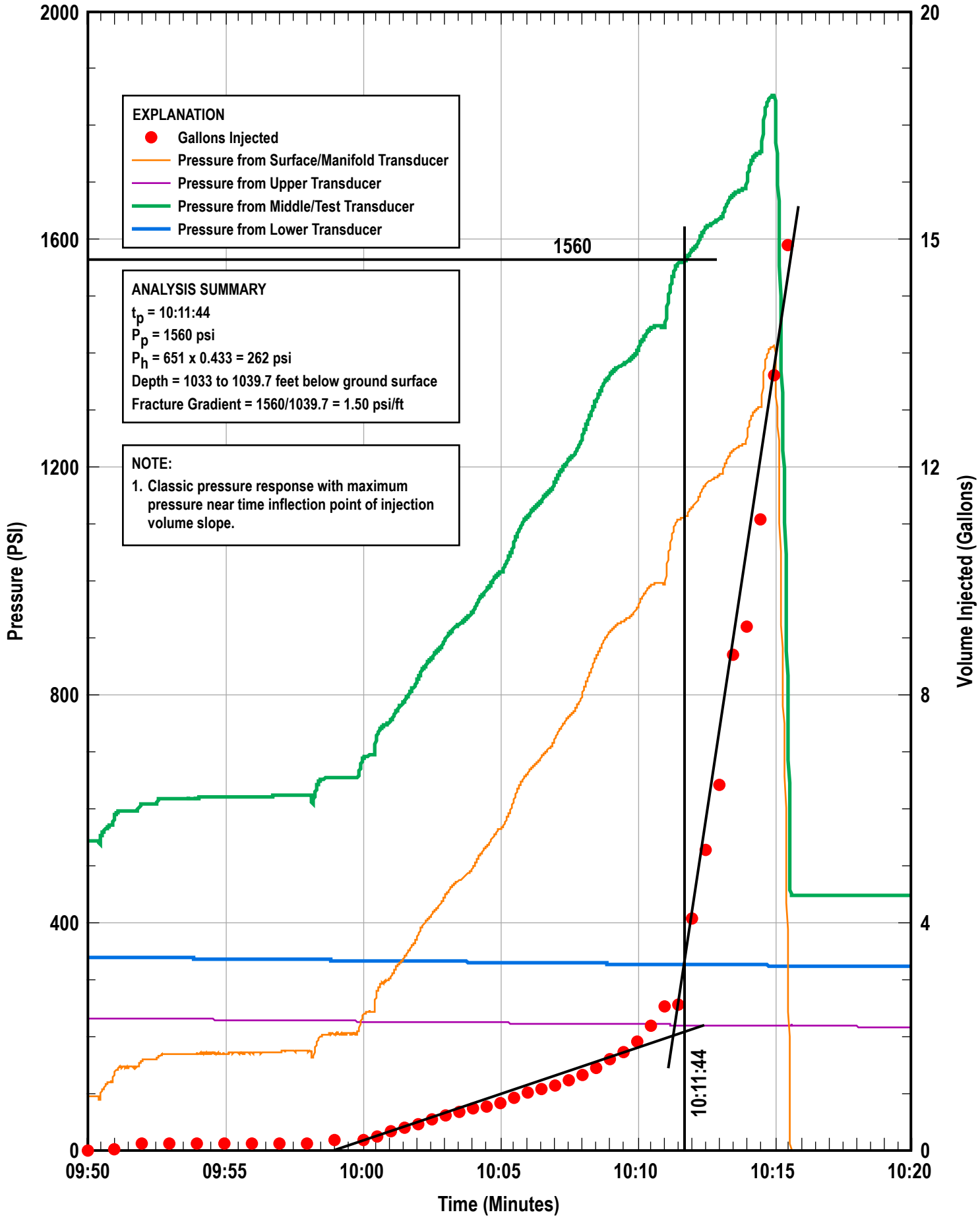
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 0950 to 1030 Hours - 1033 to 1039.7 feet below ground surface

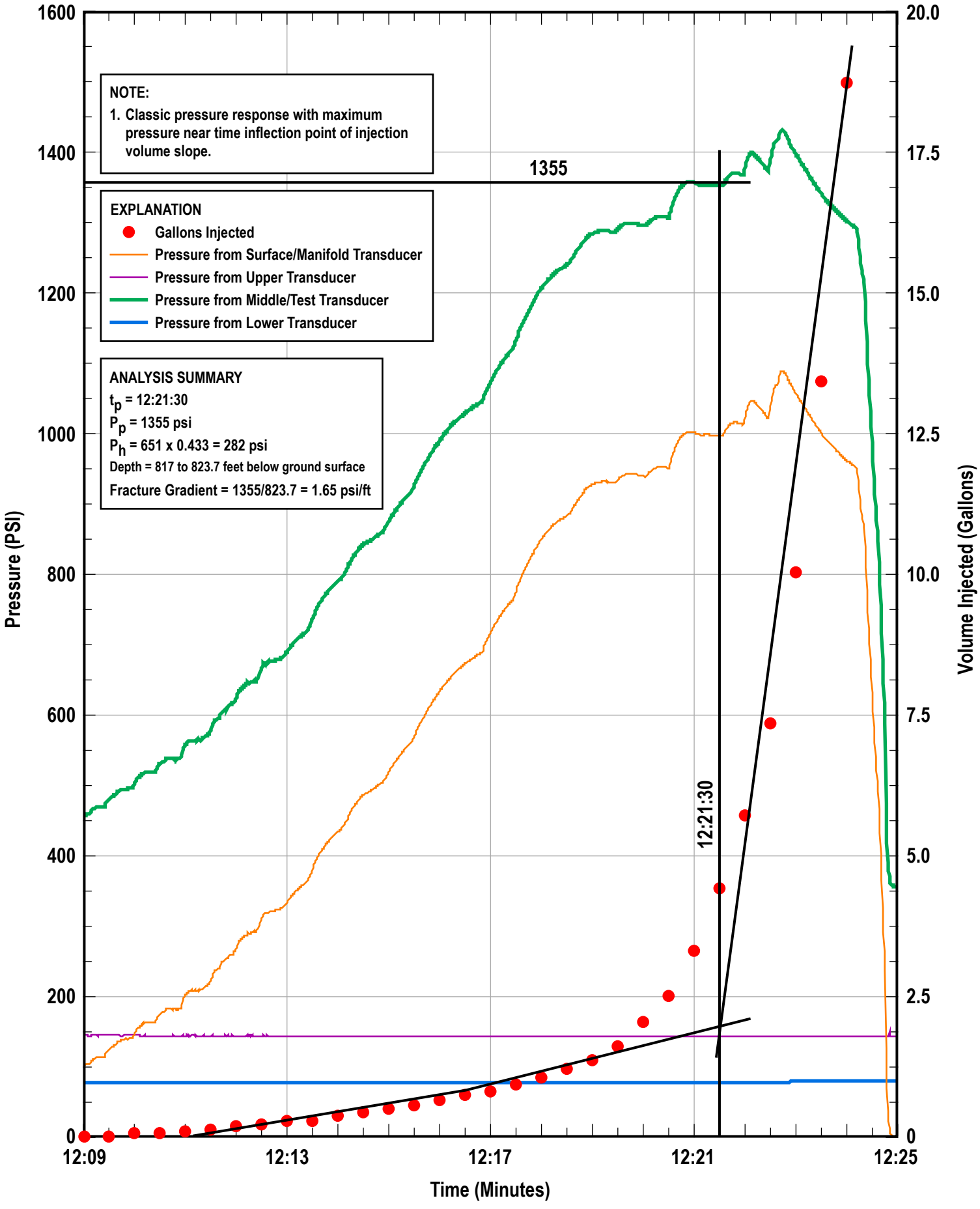
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1209 to 1230 Hours - 817 to 823.7 feet below ground surface

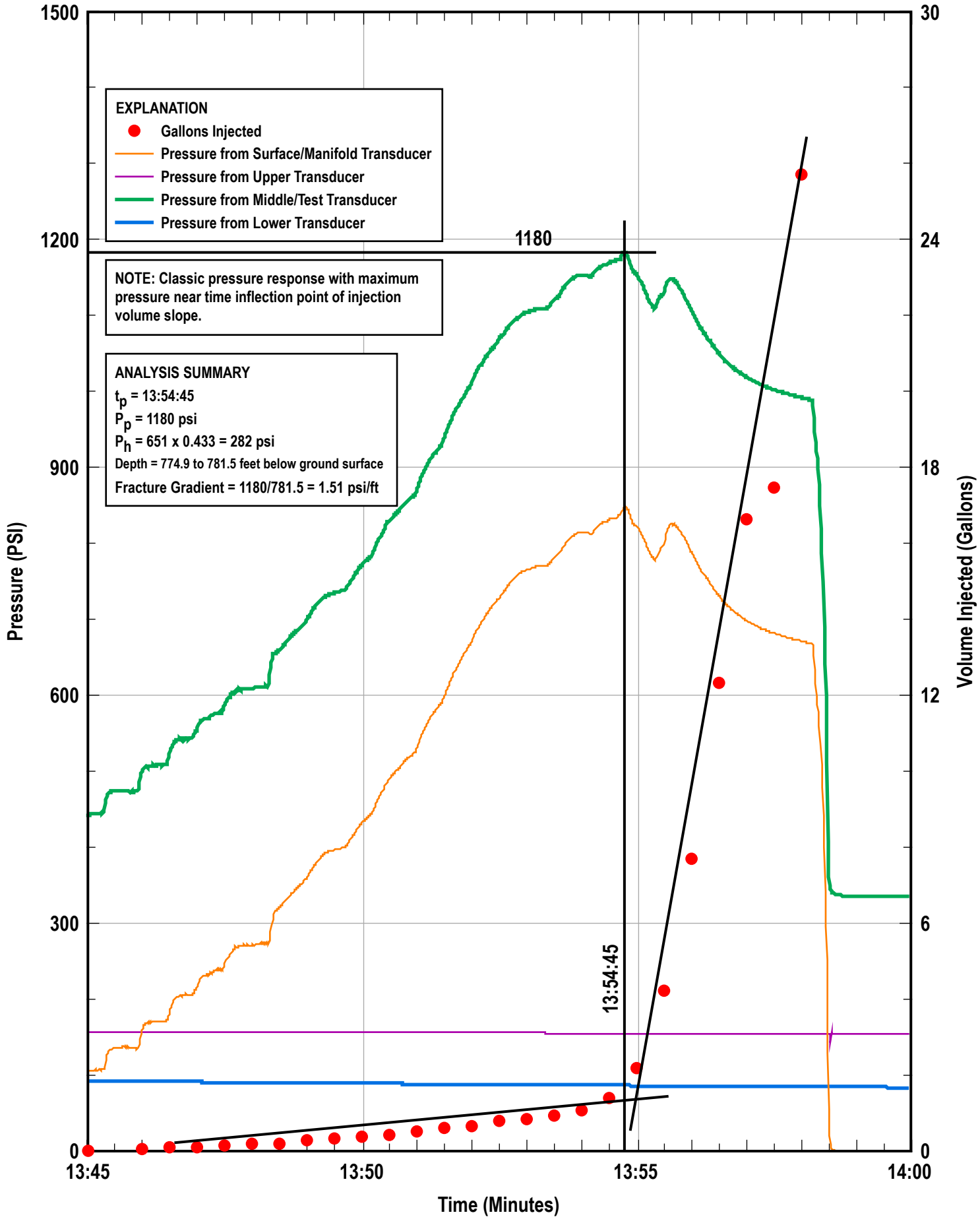
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1345 to 1400 Hours - 774.9 to 781.5 feet below ground surface

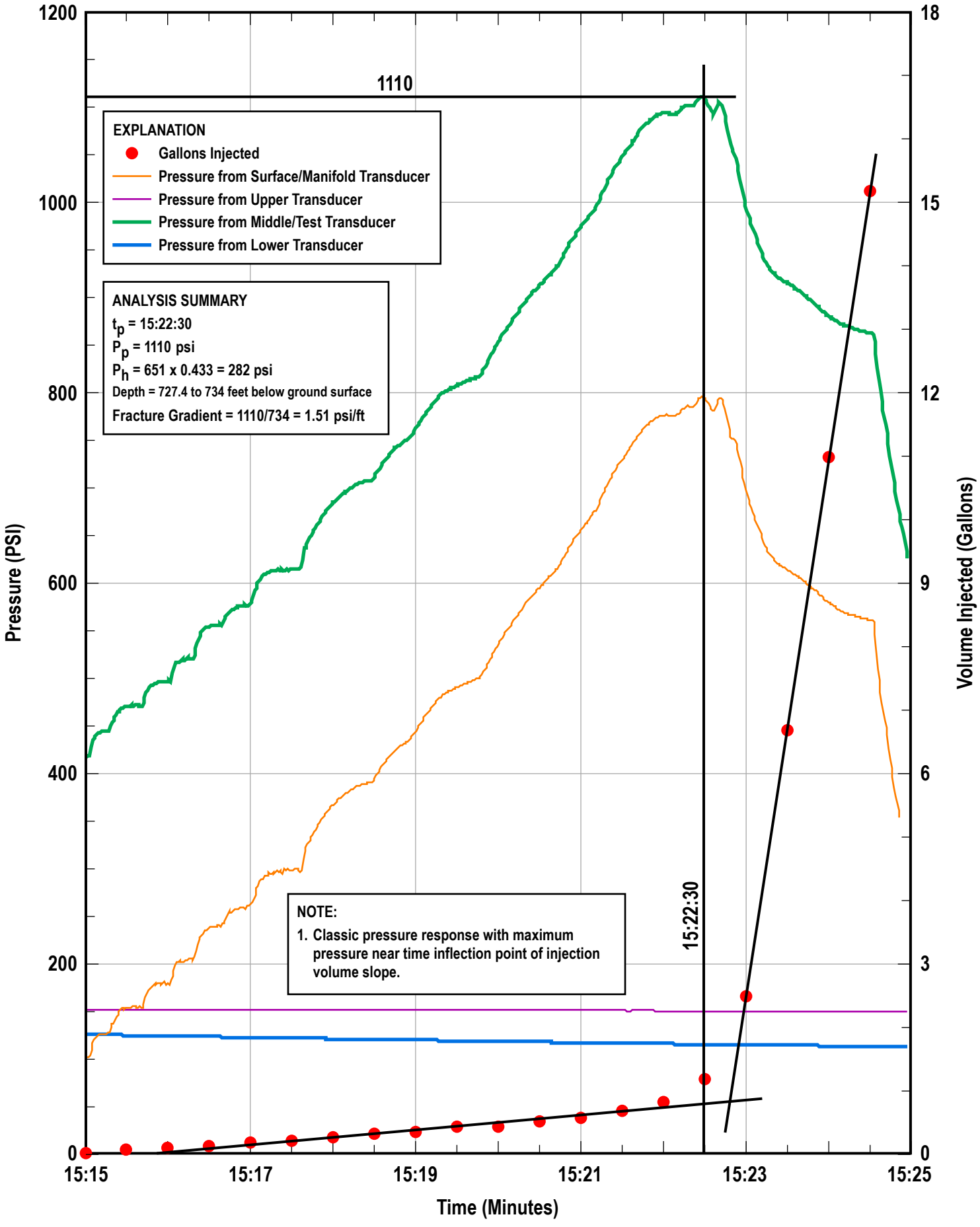
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1515 to 1525 Hours - 727.4 to 734 feet below ground surface

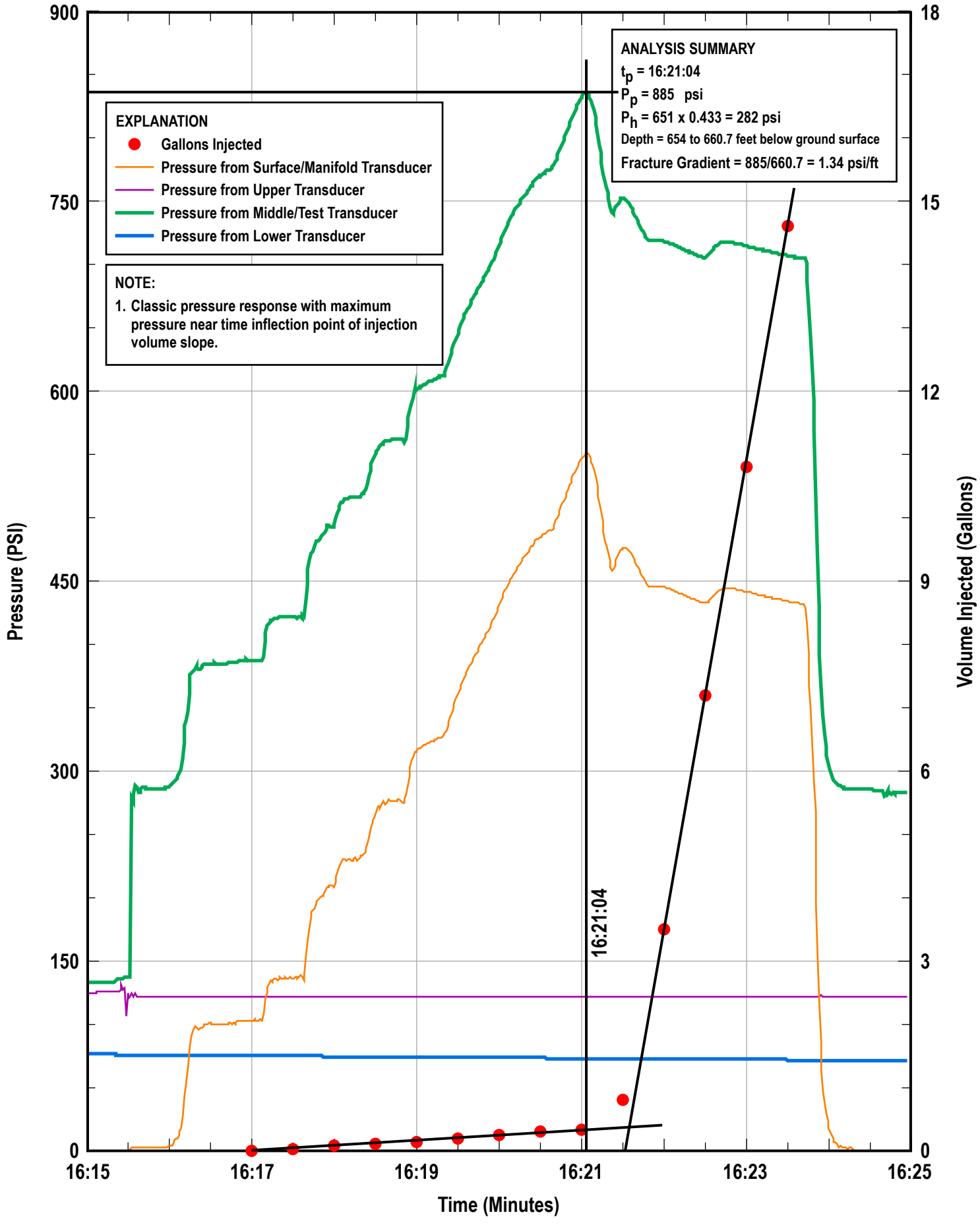
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1615 to 1625 Hours - 654 to 660.7 feet below ground surface

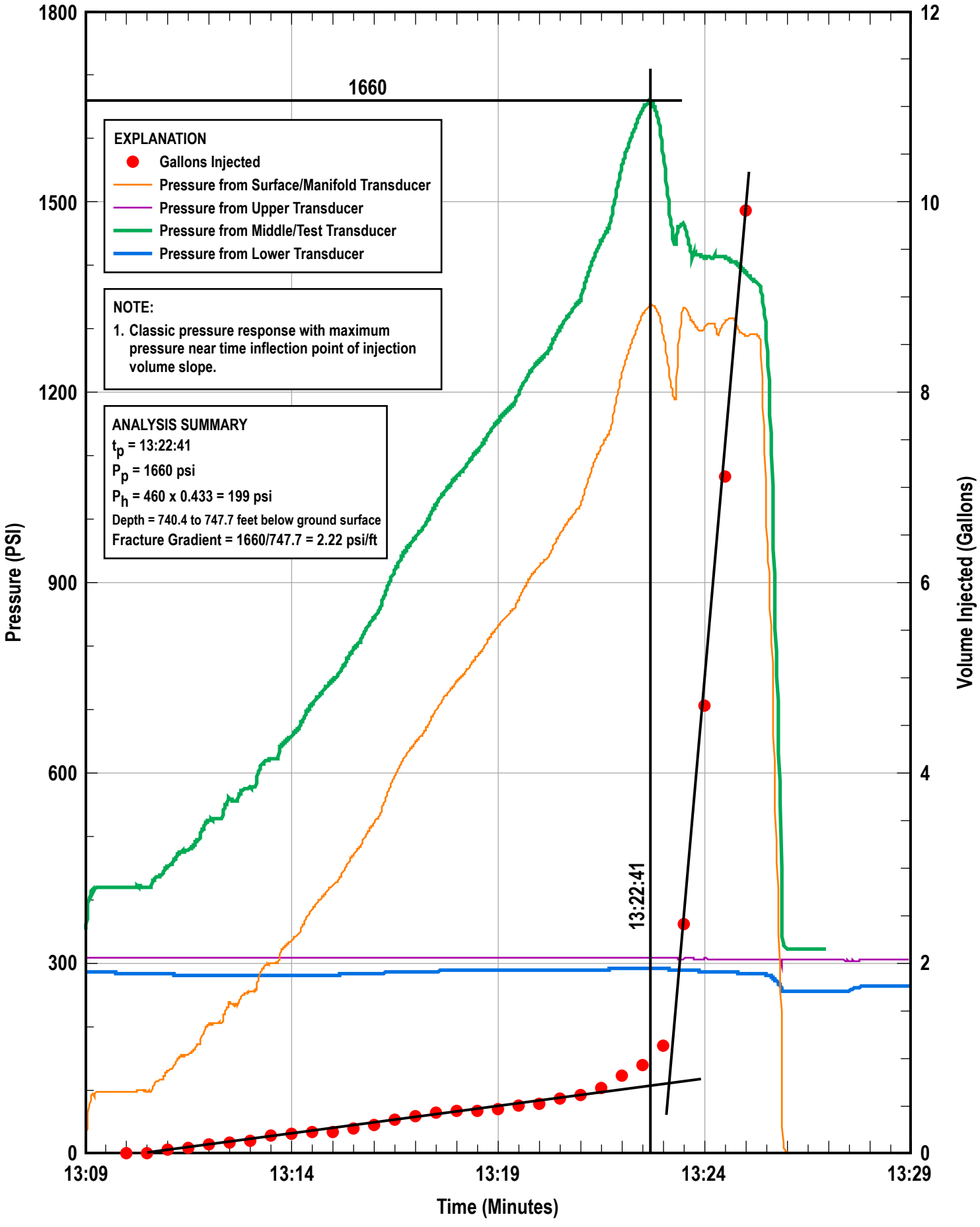
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-037

July 2, 2015 - 1309 to 1330 Hours - 740.4 to 747.7 feet below ground surface

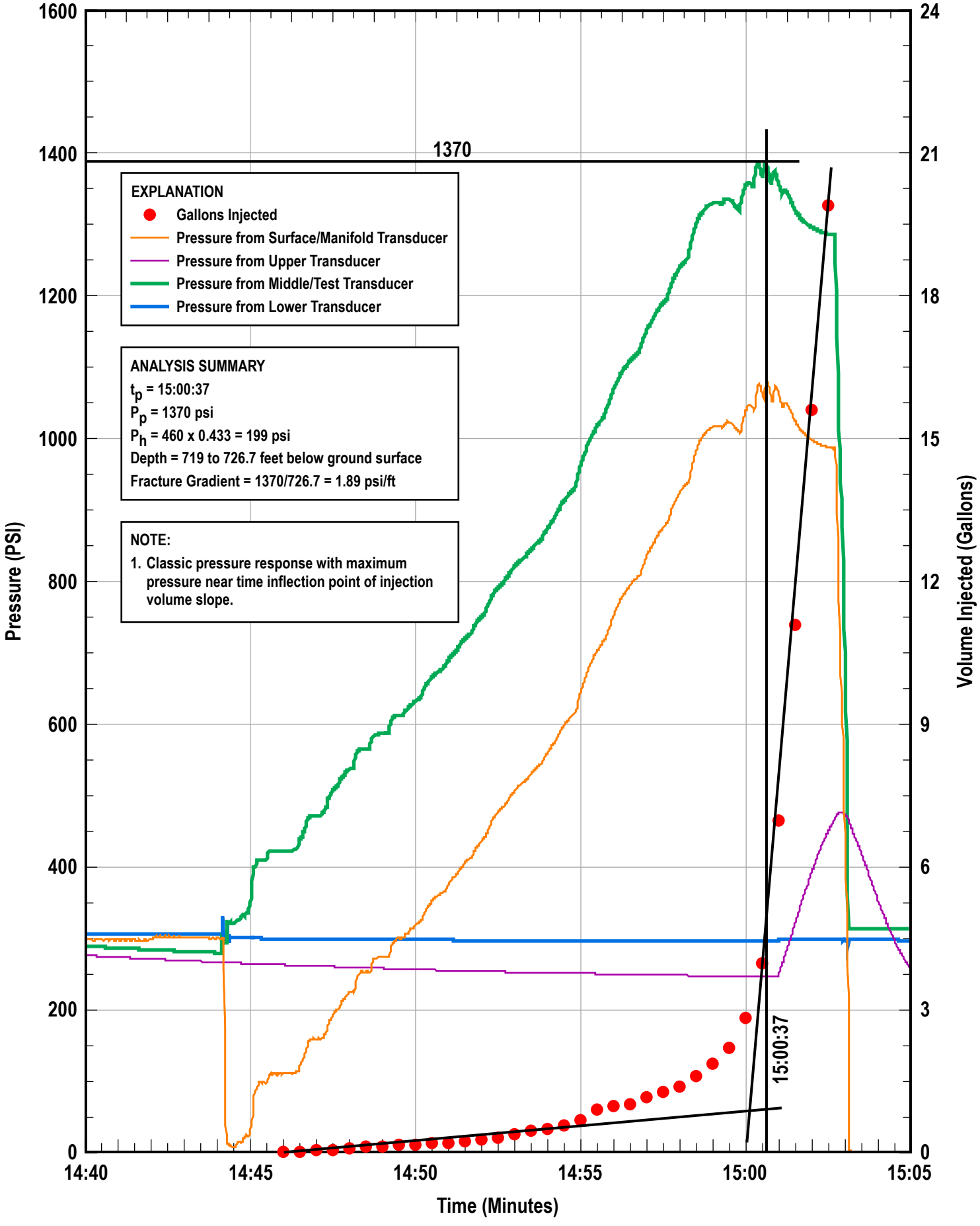
Formation Tested: Middle Abrigo



EXCELSIOR DRAGOON PROJECT - WELL NSD-037

July 2, 2015 - 1440 to 1505 Hours - 719 to 726.7 feet below ground surface

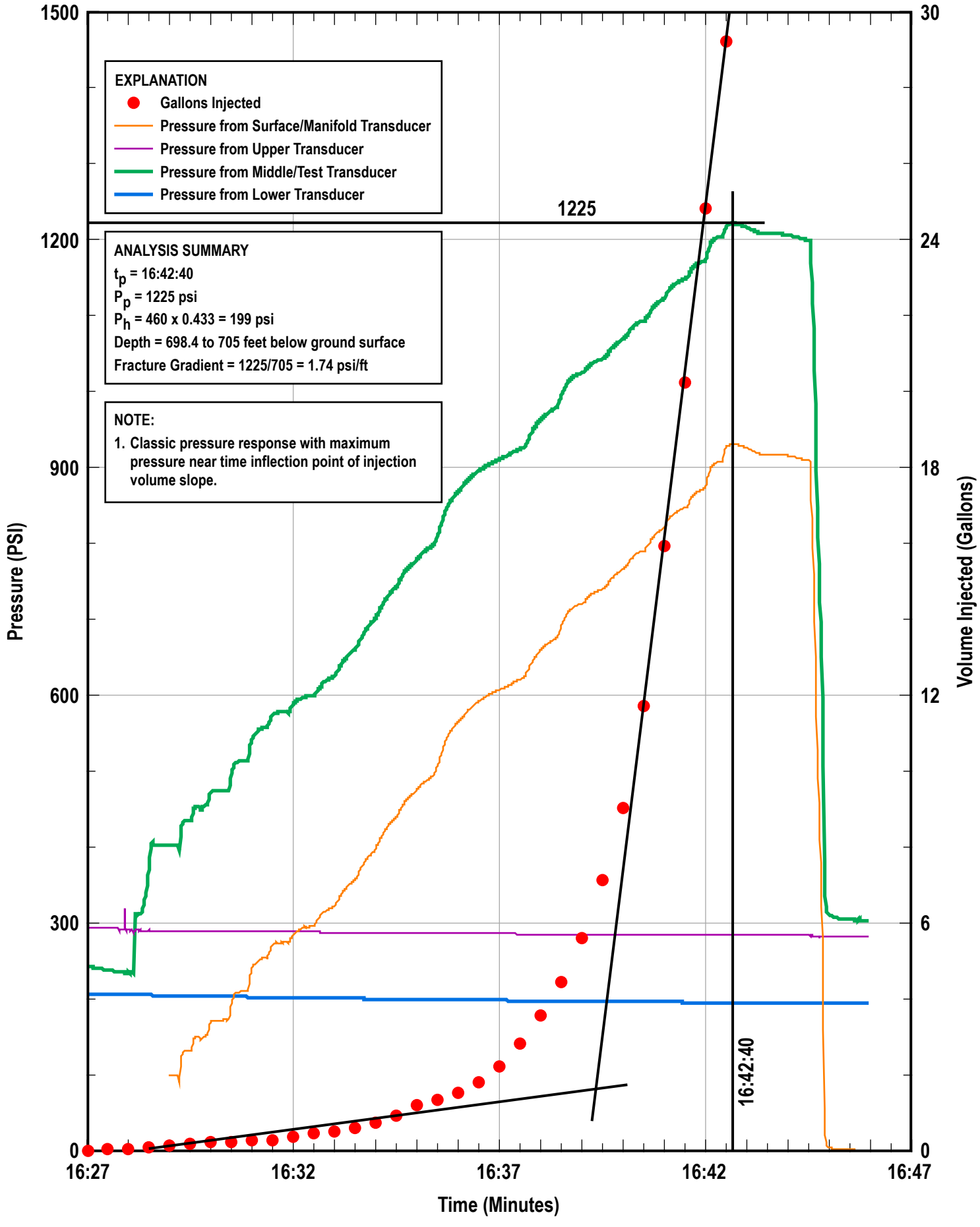
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-037

July 2, 2015 - 1627 to 1645 Hours - 698.4 to 705 feet below ground surface

Formation Tested: Martin

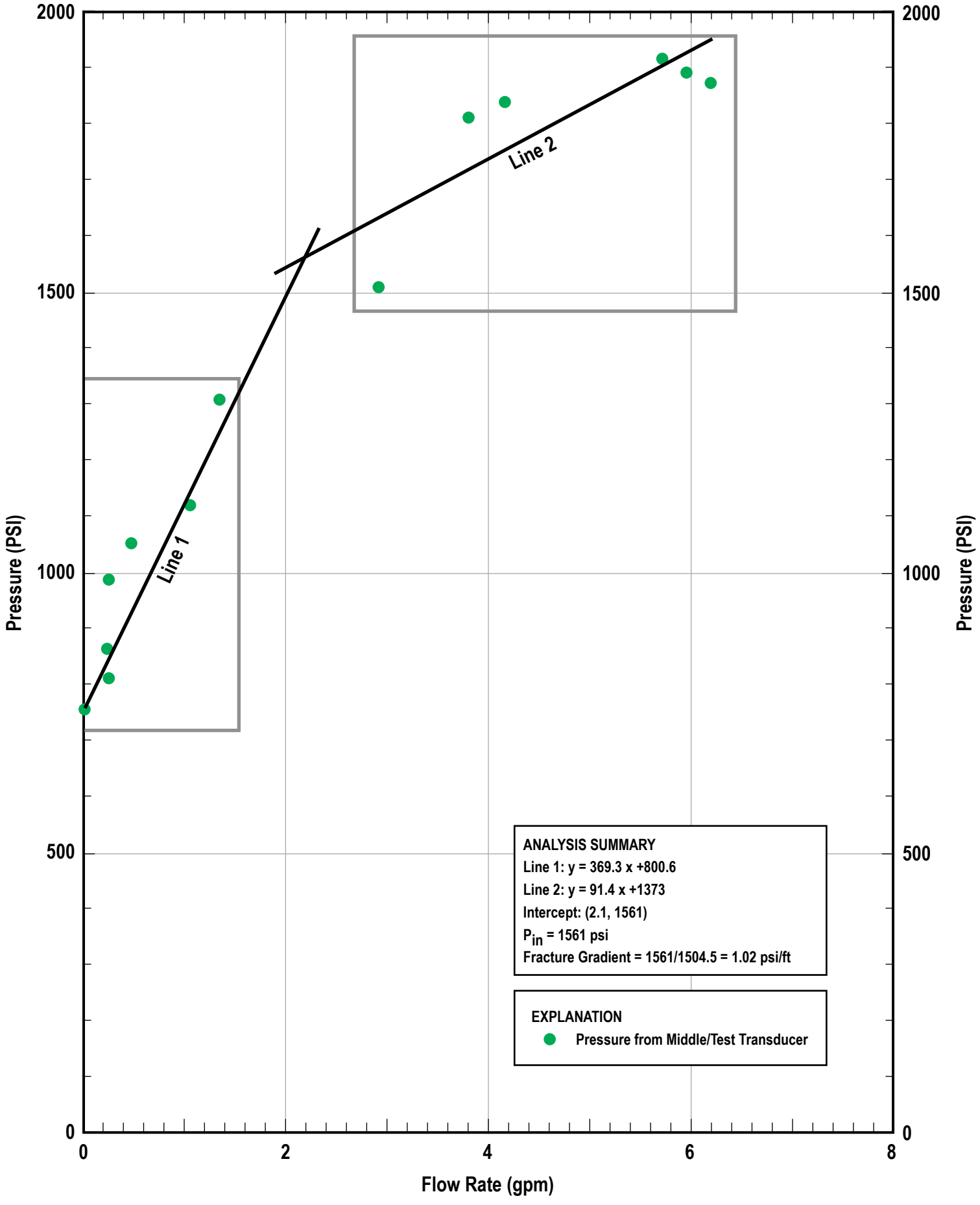


APPENDIX B

EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 21, 2015 - 1551 to 1620 Hours - 1495.5 to 1504.5 feet below ground surface

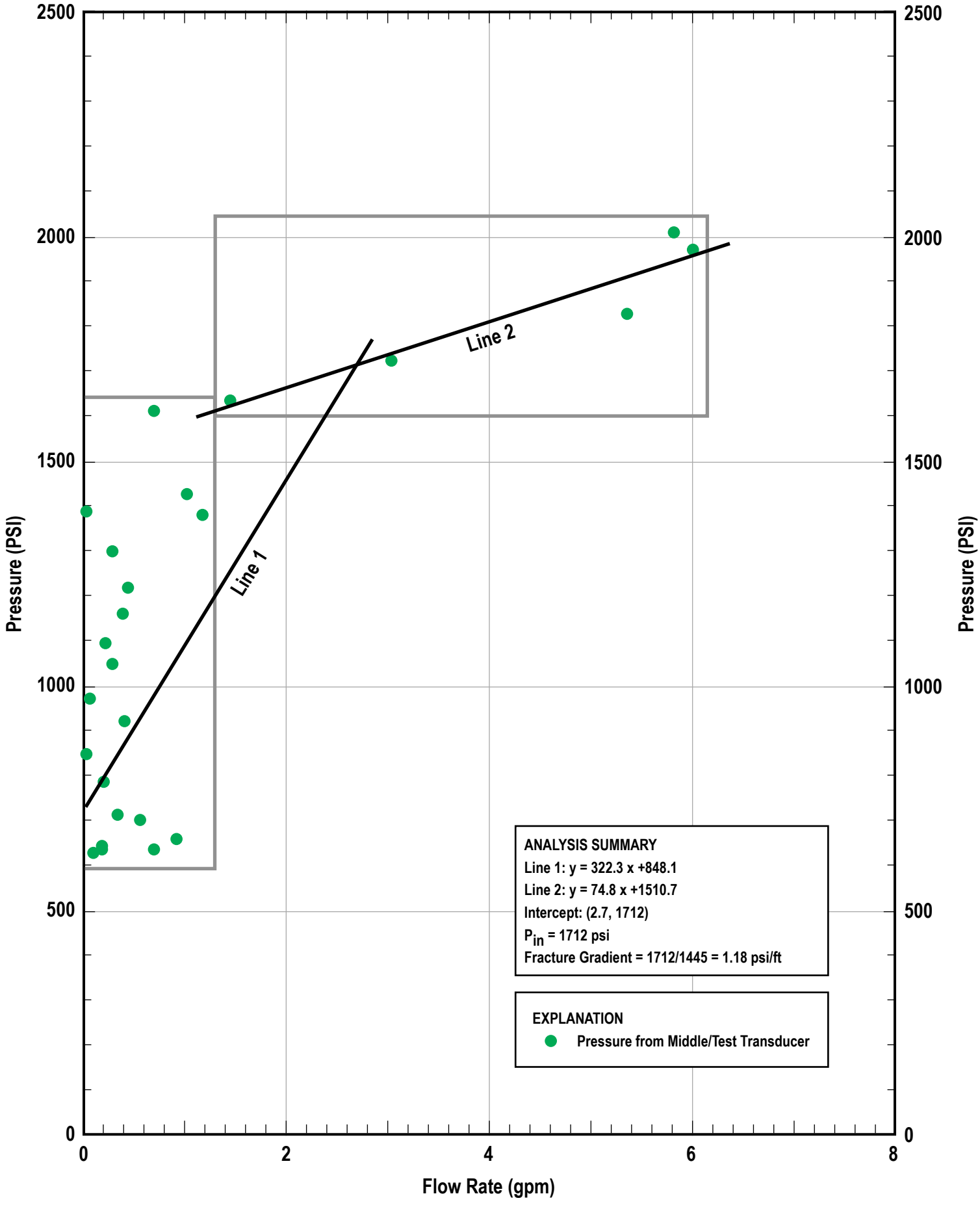
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 22, 2015 - 0635 to 0700 Hours - 1435 to 1445 feet below ground surface

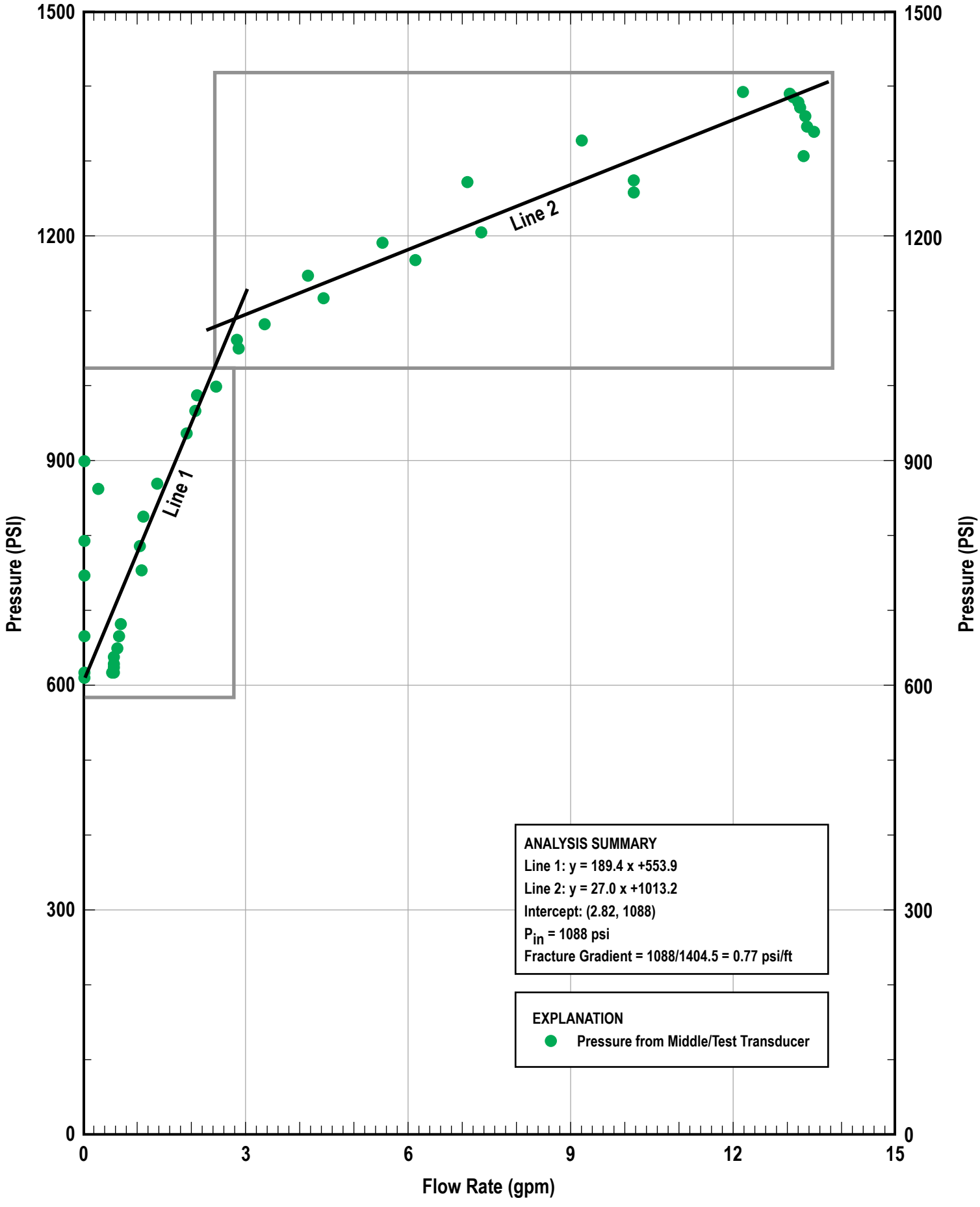
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 22, 2015 - 0824 to 0850 Hours - 1394.5 to 1404.5 feet below ground surface

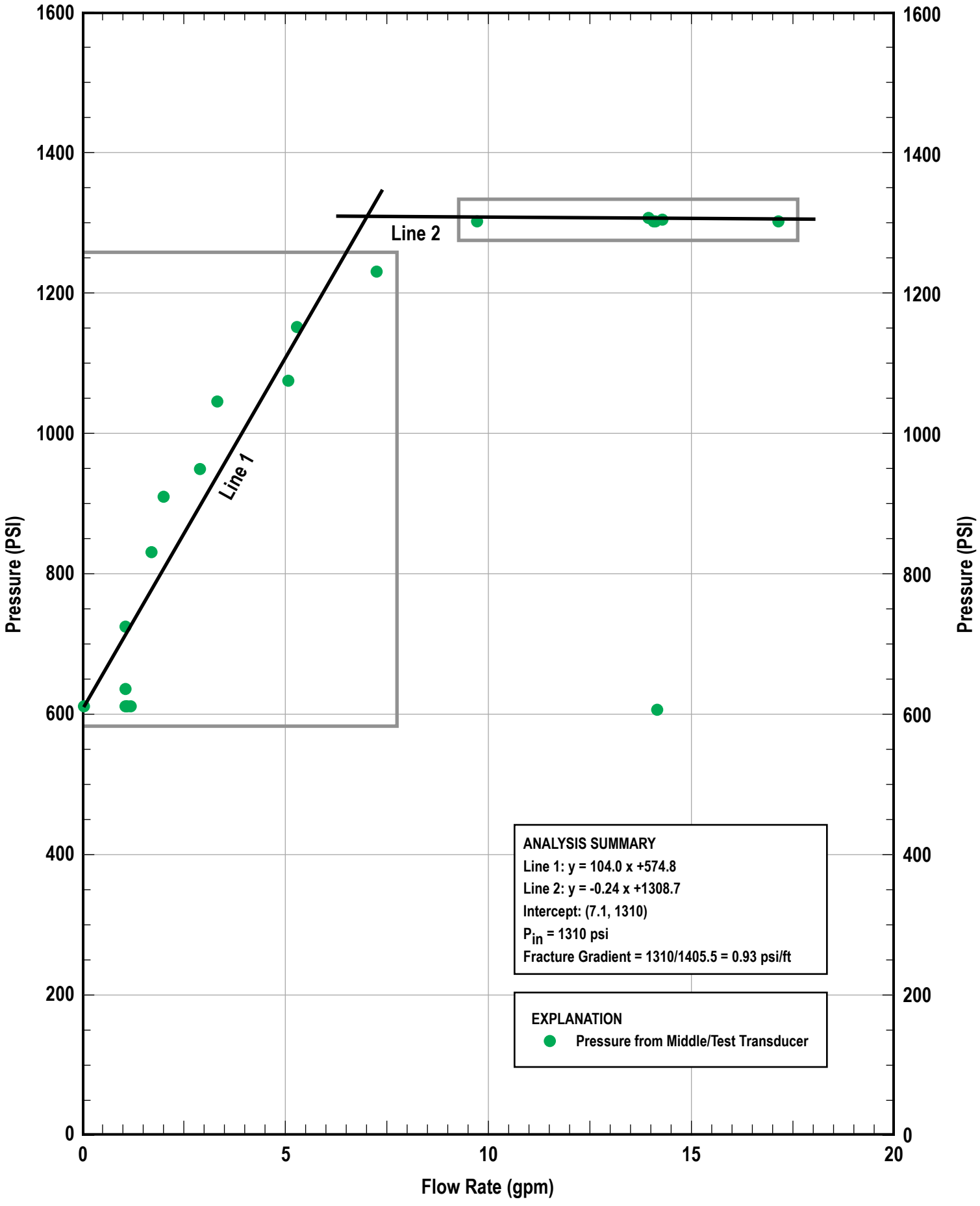
Formation Tested: Escabrosa



EXCELSIOR DRAGOON PROJECT - WELL NSD-043

June 22, 2015 - 0950 to 1010 Hours - 1395.5 to 1405.5 feet below ground surface

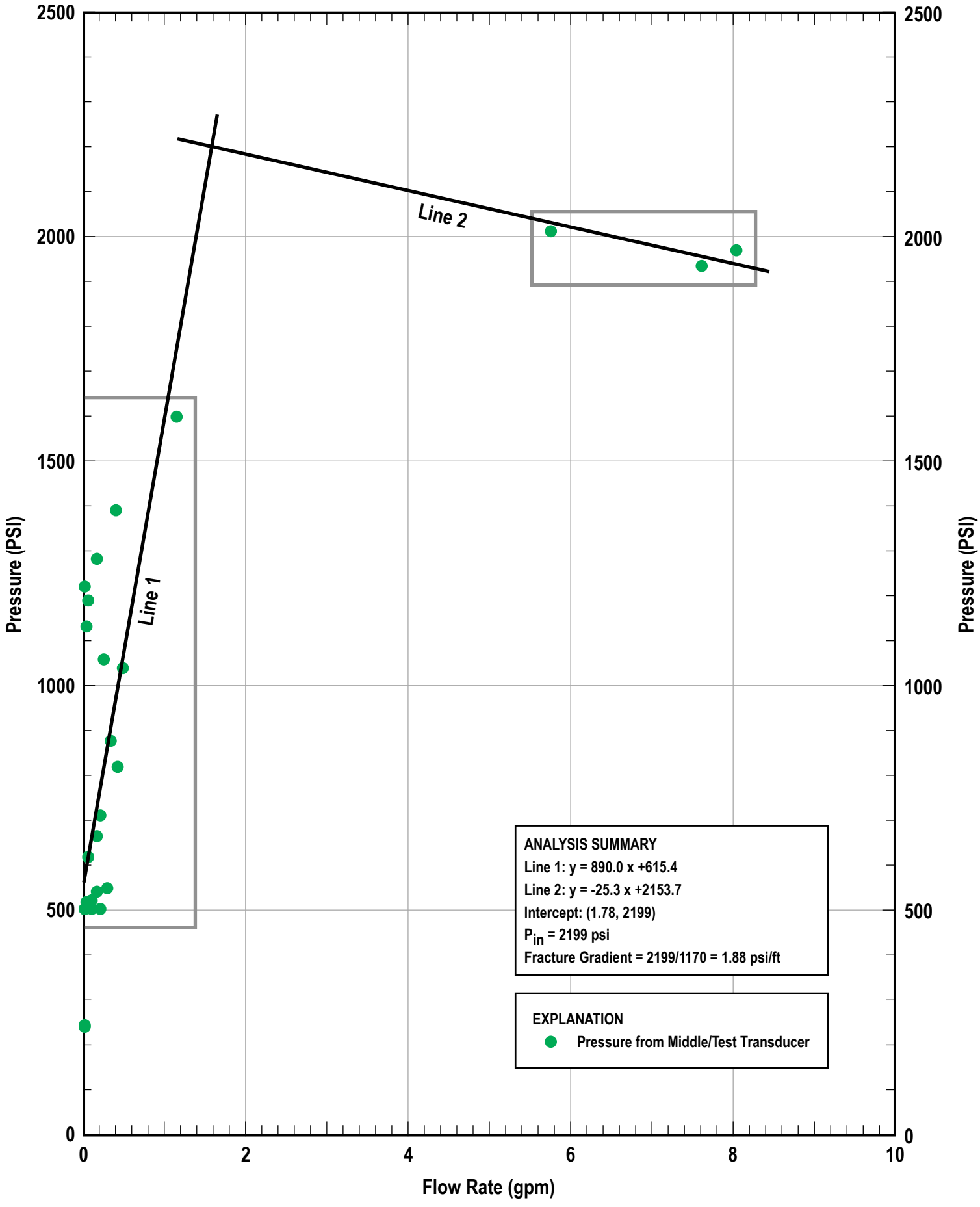
Formation Tested: Escabrosa



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 22, 2015 - 1617 to 1631 Hours - 1163.4 to 1170 feet below ground surface

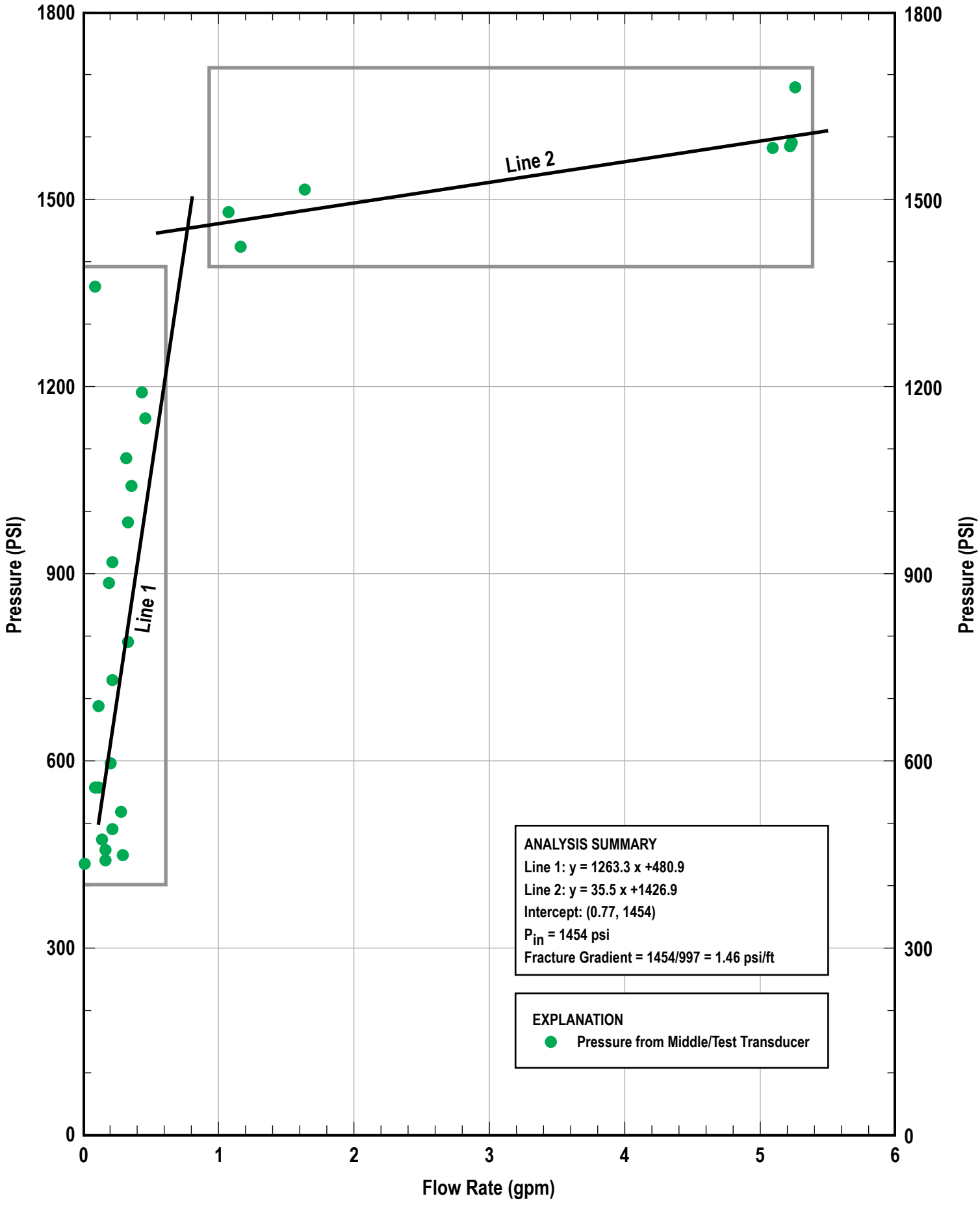
Formation Tested: Escabrosa



EXCELSIOR GUNNISON PROJECT - WELL NSD-043

June 23, 2015 - 0657 to 0715 - (989.9 to 996.5 feet below ground surface)

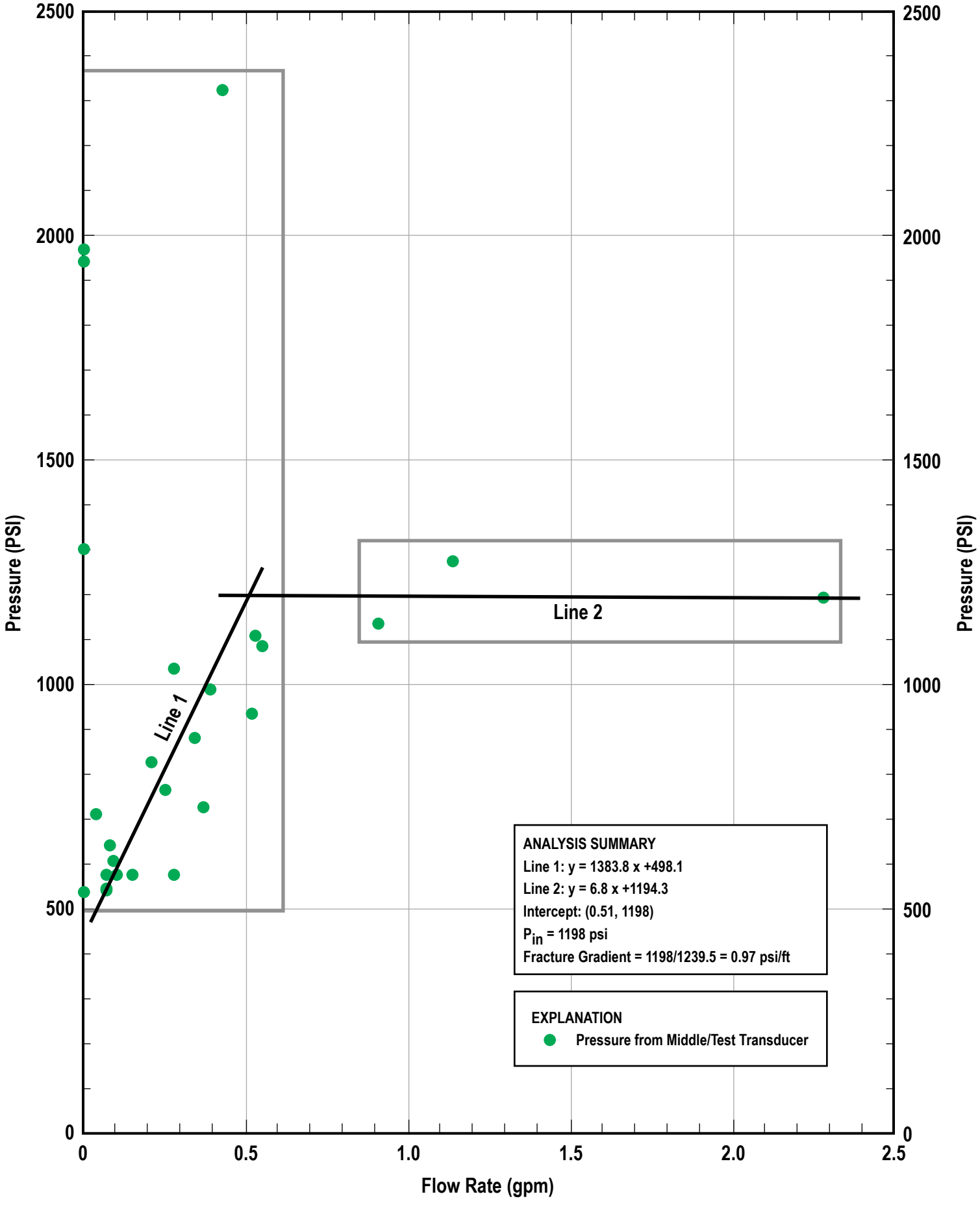
Formation Tested: Horquilla



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 0715 to 0730 Hours - 1233 to 1239.5 feet below ground surface

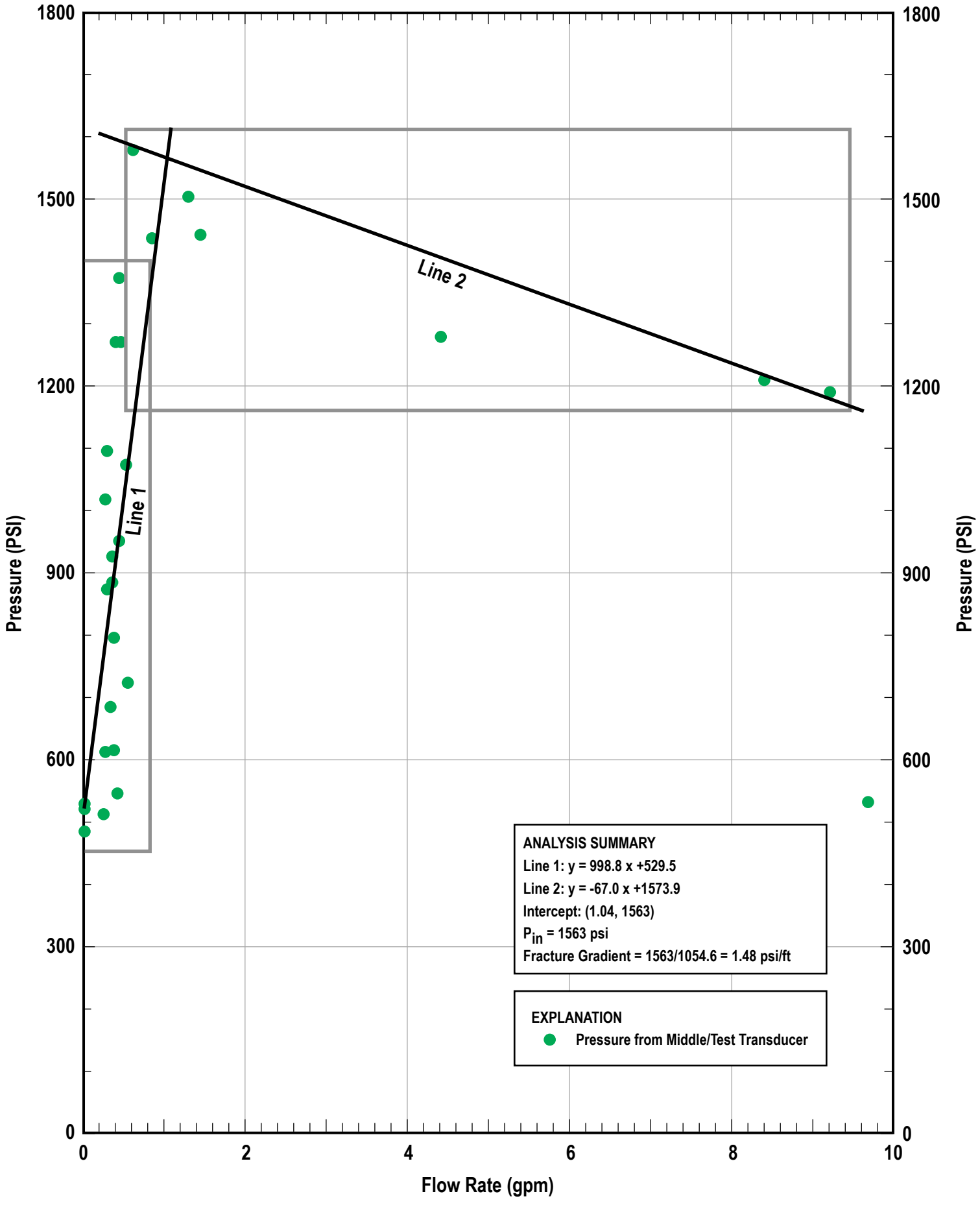
Formation Tested: Lower Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 0922 to 0936 Hours - 1048 to 1054.6 feet below ground surface

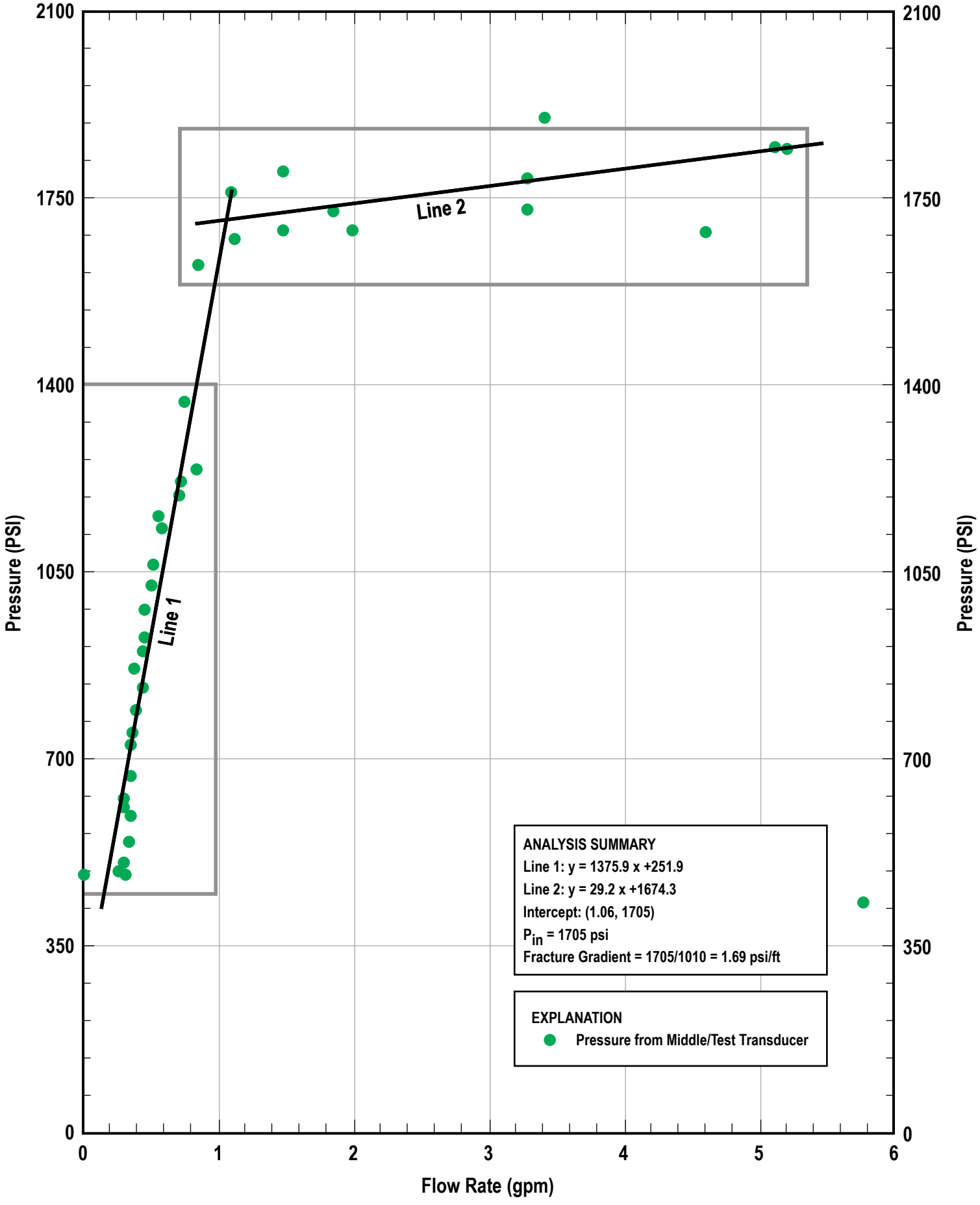
Formation Tested: Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 1130 to 1150 Hours - 1003.5 to 1010 feet below ground surface

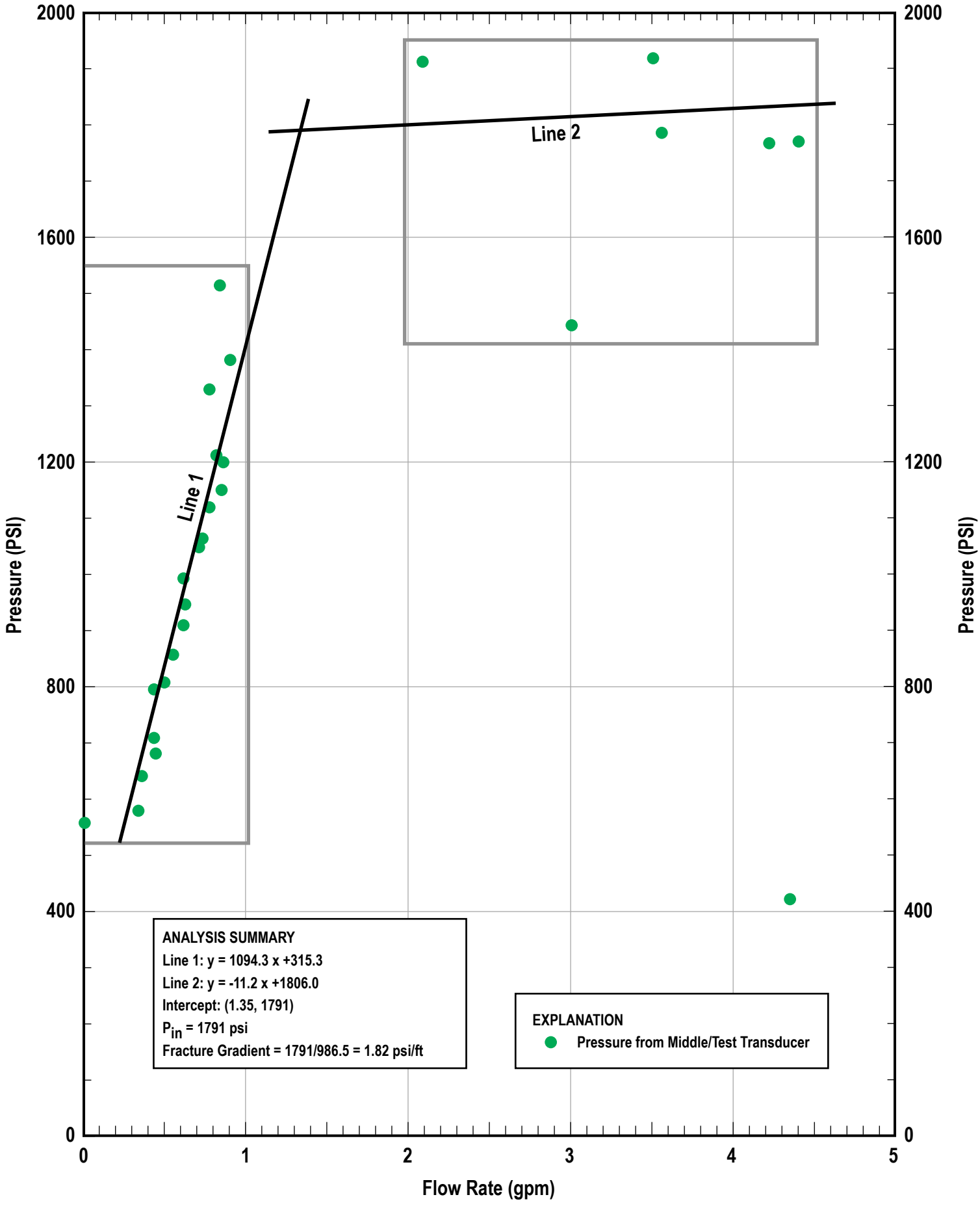
Formations Tested: Upper/Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 24, 2015 - 1335 to 1350 Hours - 979.85 to 986.5 feet below ground surface

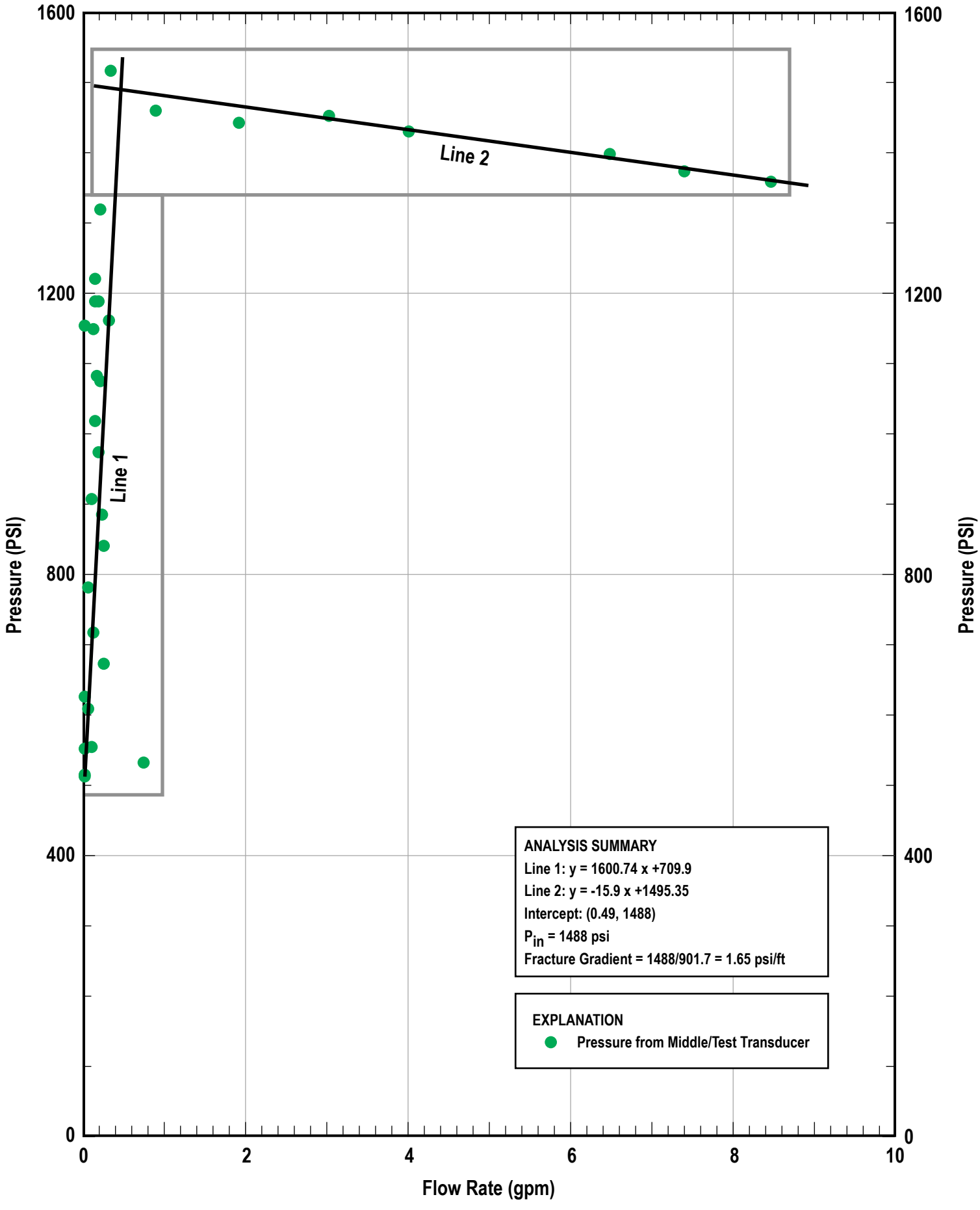
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-008

June 25, 2015 - 0757 to 0815 Hours - 895 to 901.7 feet below ground surface

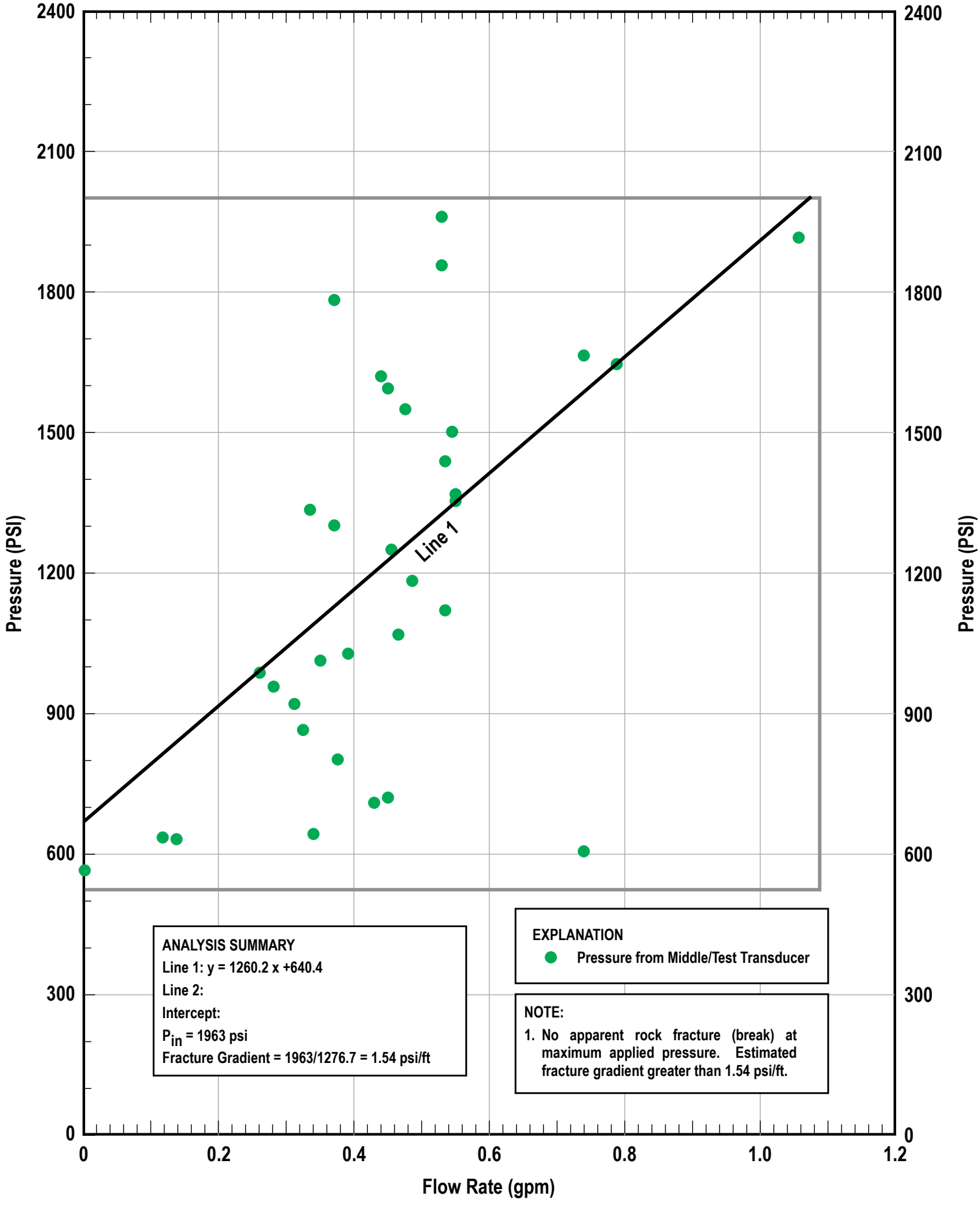
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-009

June 26, 2015 - 1559 to 1520 Hours - 1270 to 1276.7 feet below ground surface

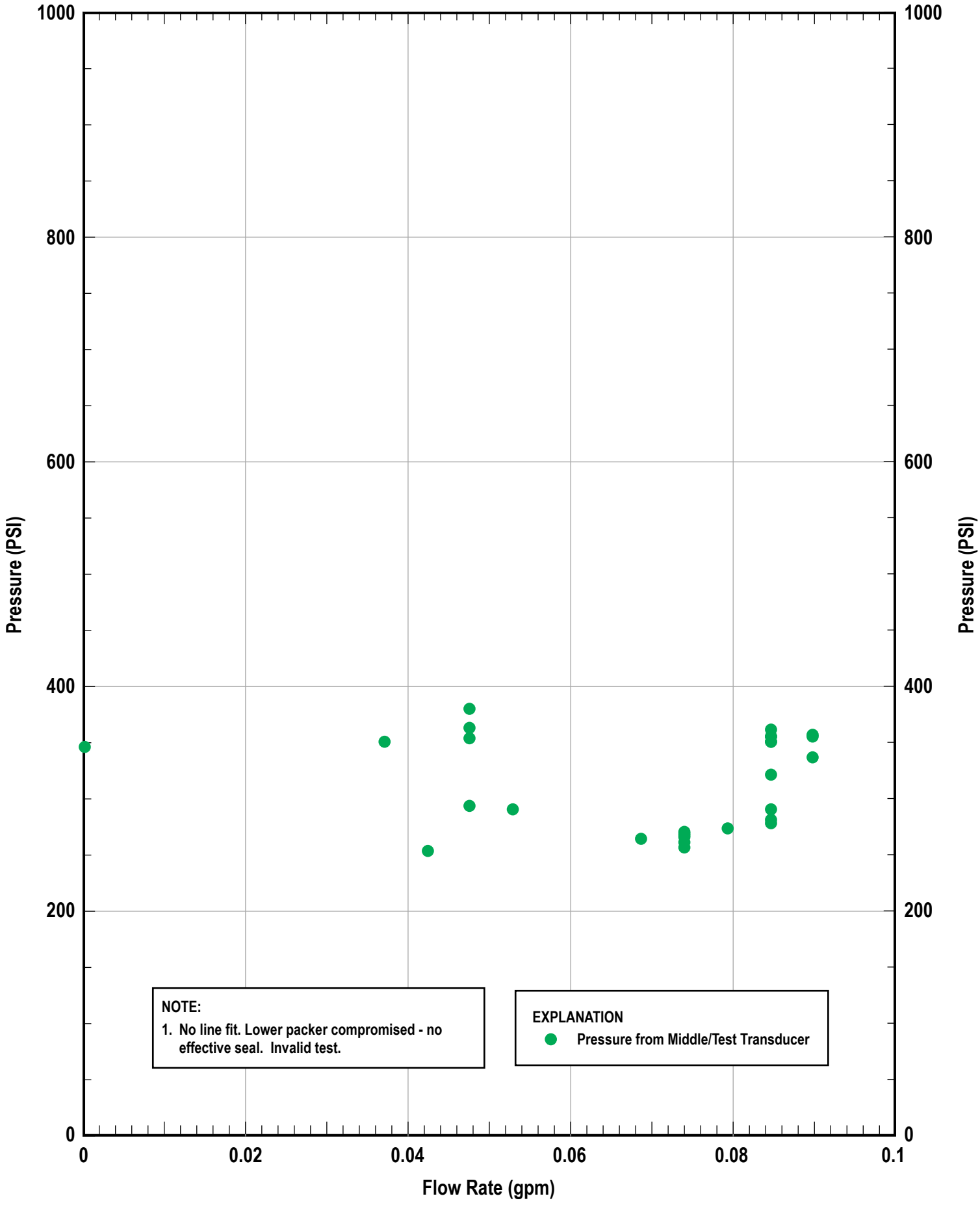
Formation Tested: Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-009

June 27, 2015 - 0625 to 0650 Hours - 1095.5 to 1102 feet below ground surface

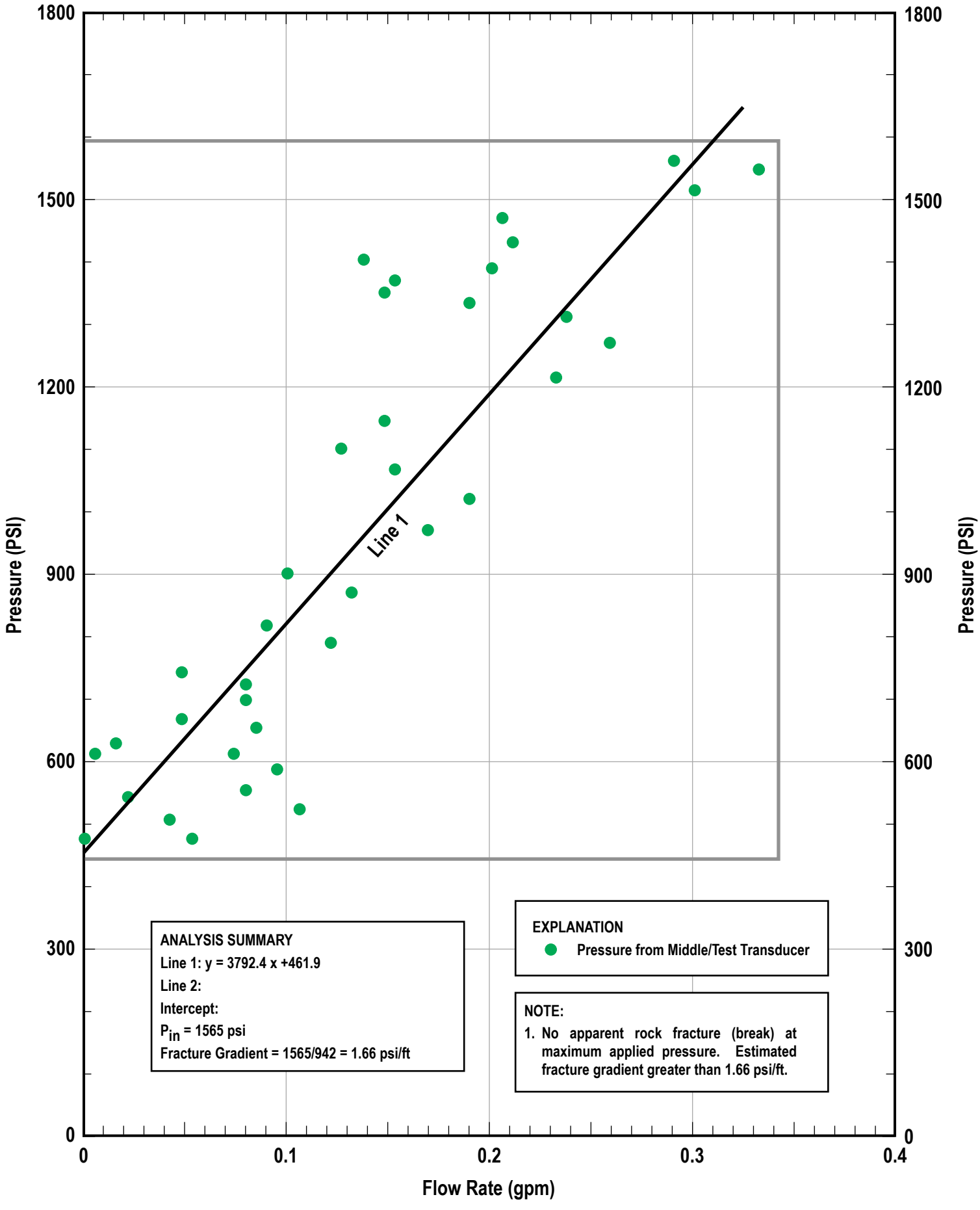
Formation Tested: No Test



EXCELSIOR GUNNISON PROJECT - WELL NSM-009

June 27, 2015 - 1055 to 1120 Hours - 935.4 to 942 feet below ground surface

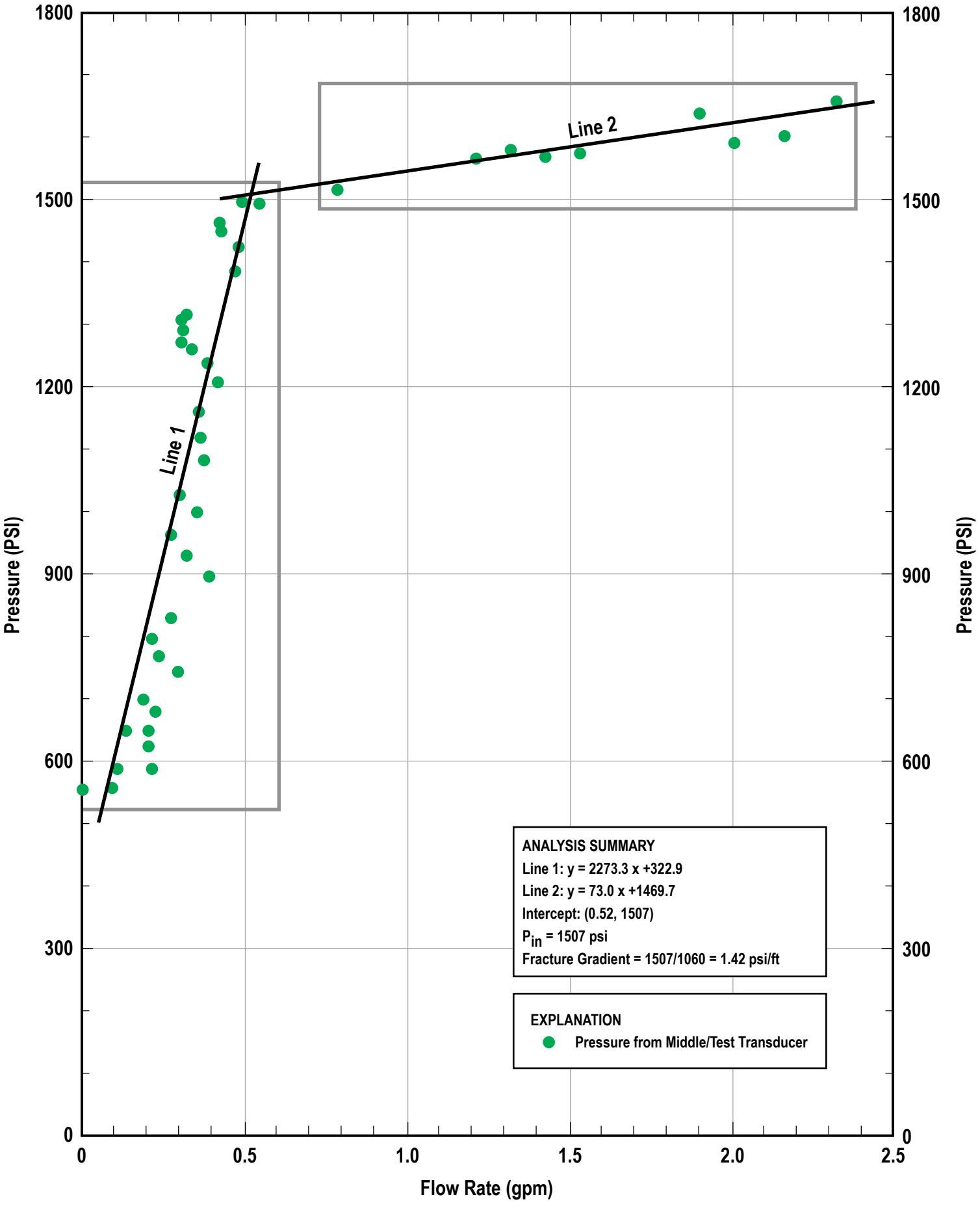
Formation Tested: Upper/Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 28, 2015 - 0831 to 0855 Hours - 1053.5 to 1060 feet below ground surface

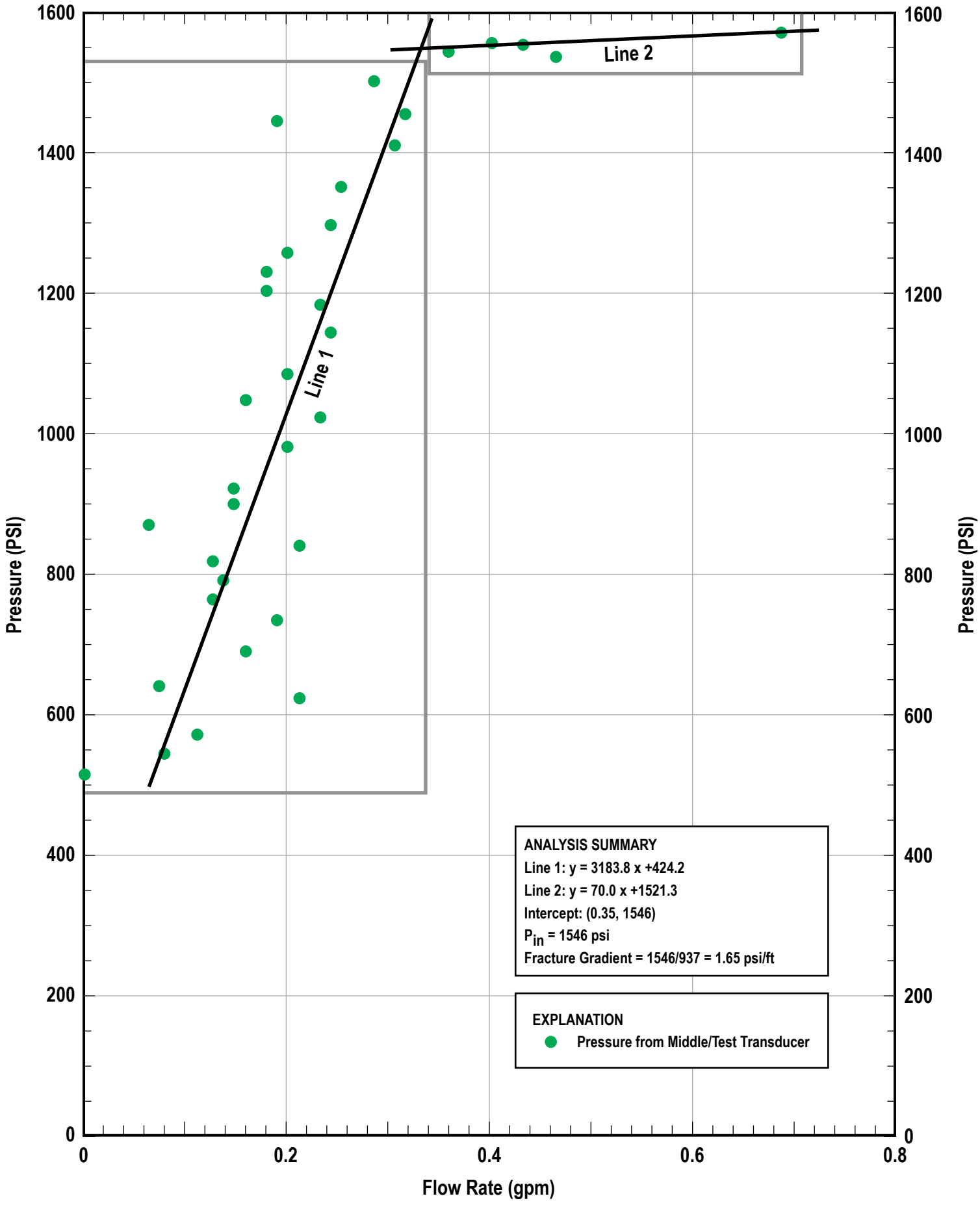
Formation Tested: Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 28, 2015 - 1305 to 1325 Hours - 930.4 to 937 feet below ground surface

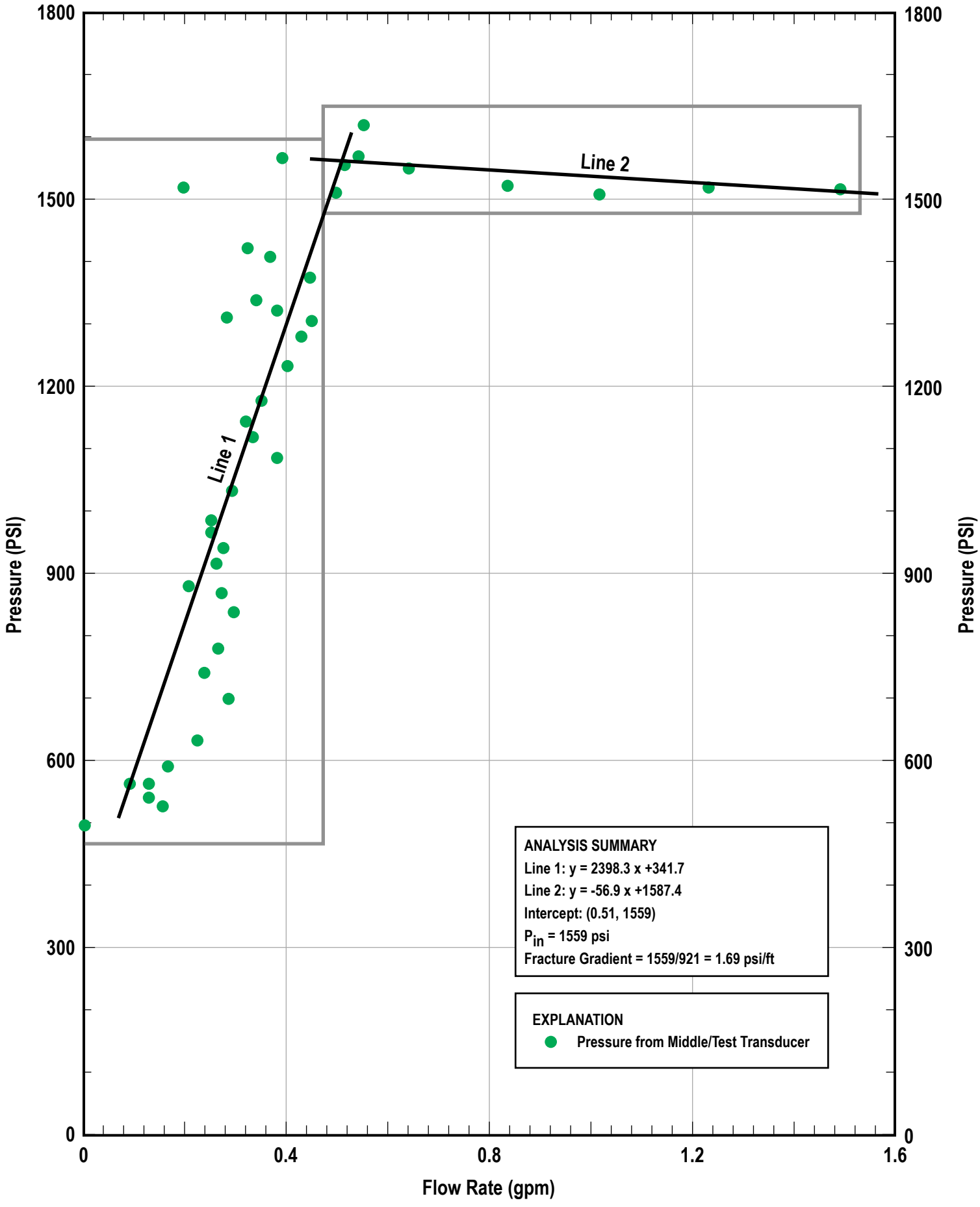
Formation Tested: Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 28, 2015 - 1503 to 1530 Hours - 914.4 to 921 feet below ground surface

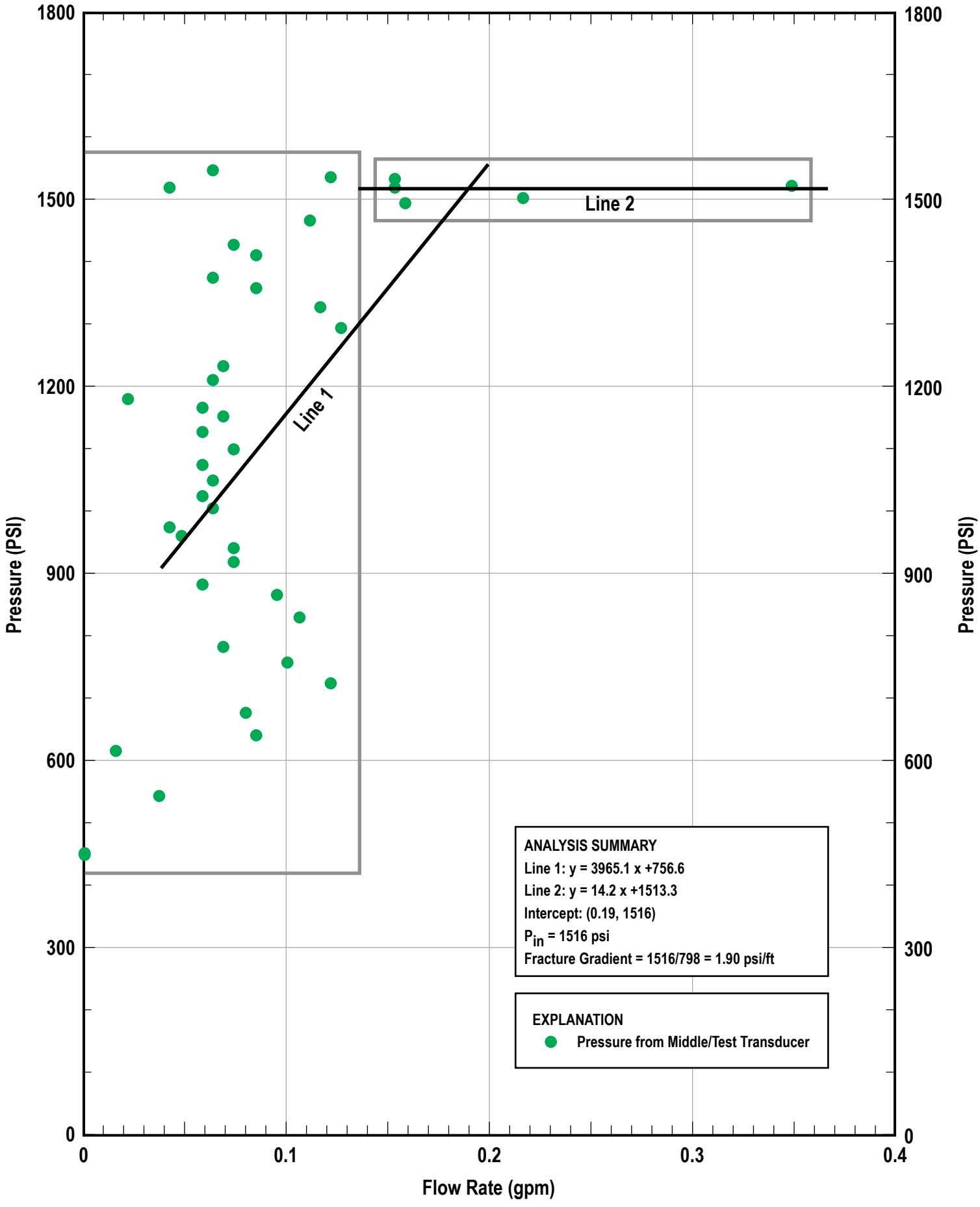
Formations Tested: Upper/Middle Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 29, 2015 - 0615 to 0650 Hours - 791.4 to 798 feet below ground surface

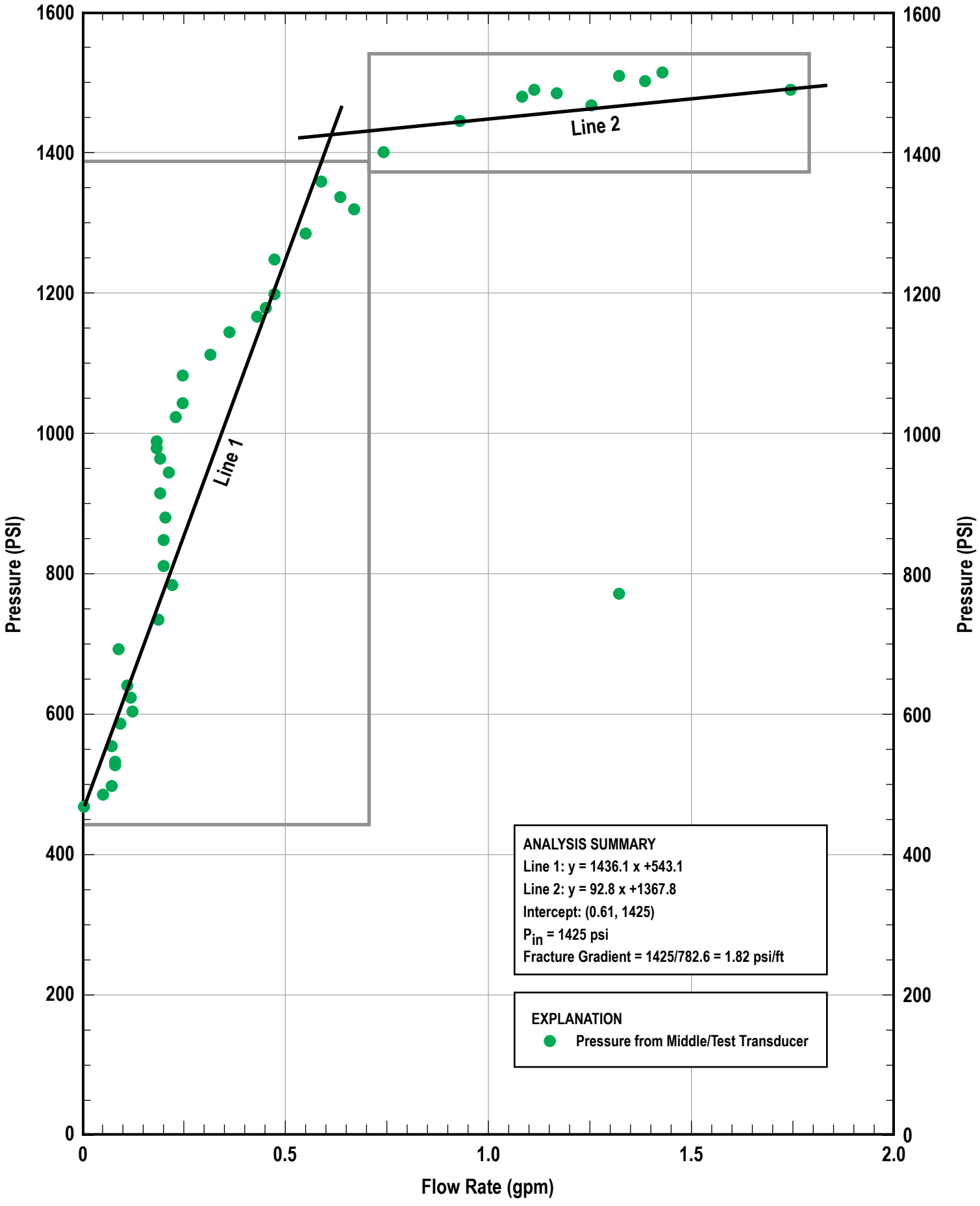
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 29, 2015 - 0750 to 0820 Hours - 775.9 to 782.6 feet below ground surface

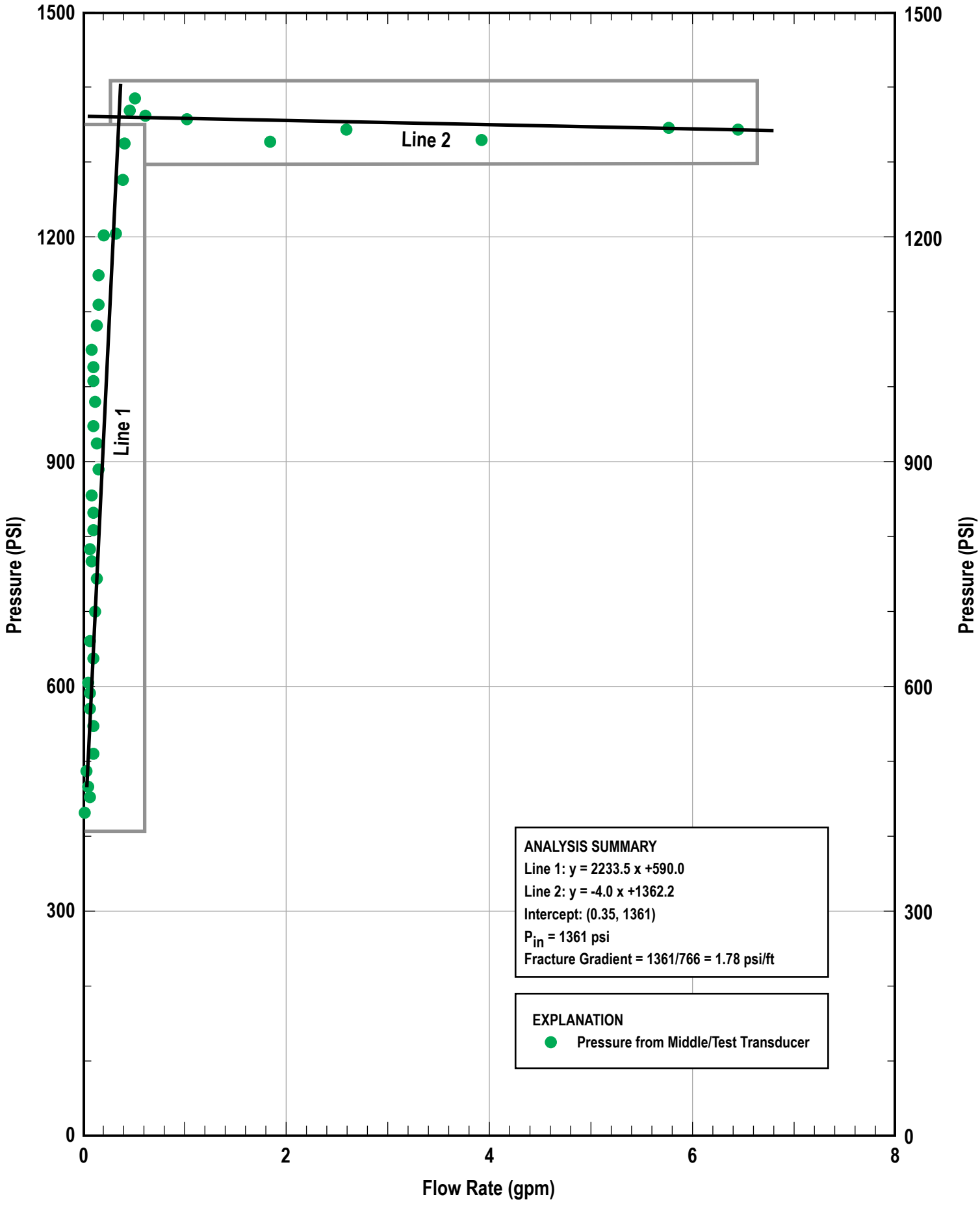
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-006

June 29, 2015 - 0939 to 1005 Hours - 759.4 to 766 feet below ground surface

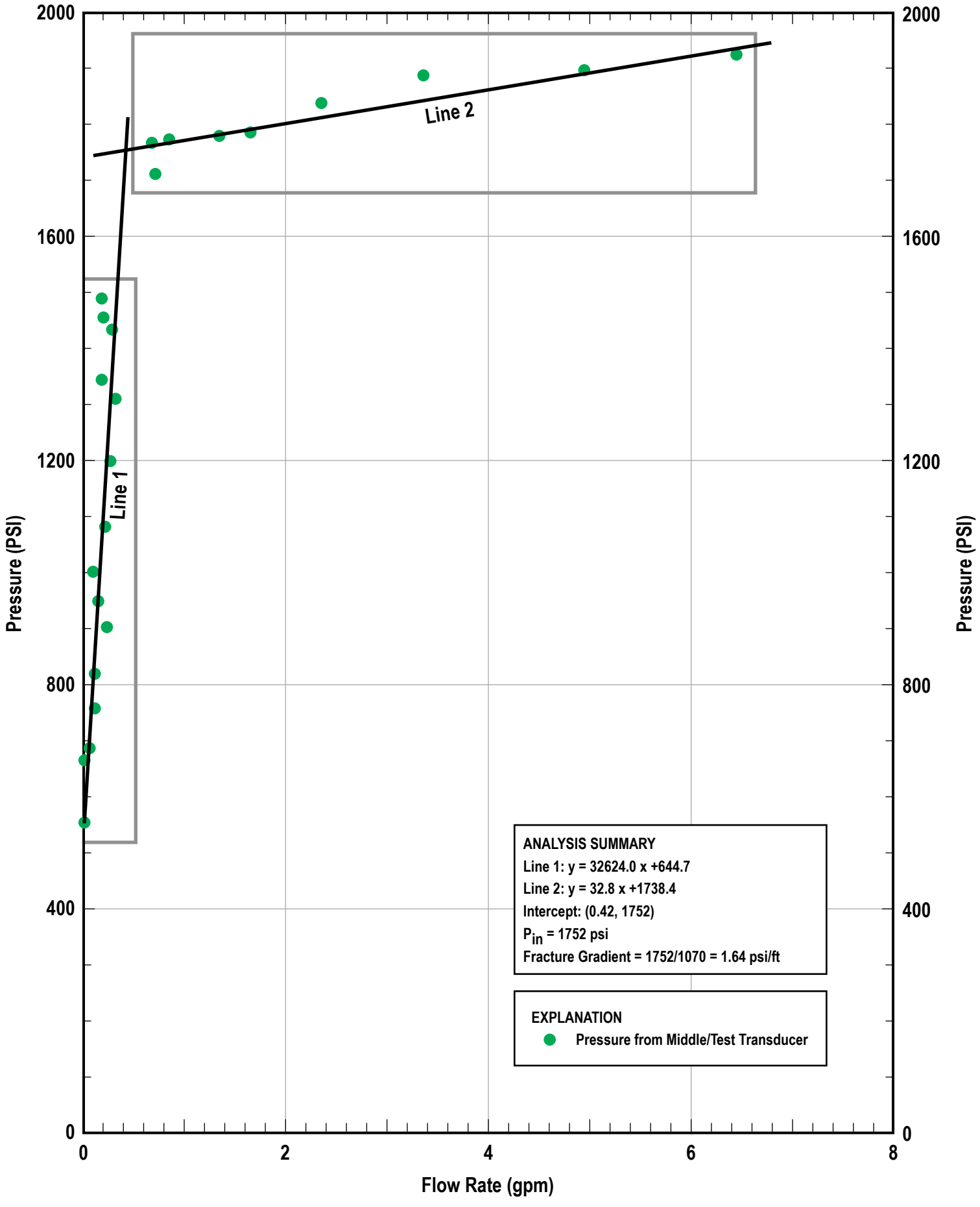
Formation Tested: Upper Abrigo



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 0808 to 0831 Hours - 1063.4 to 1070 feet below ground surface

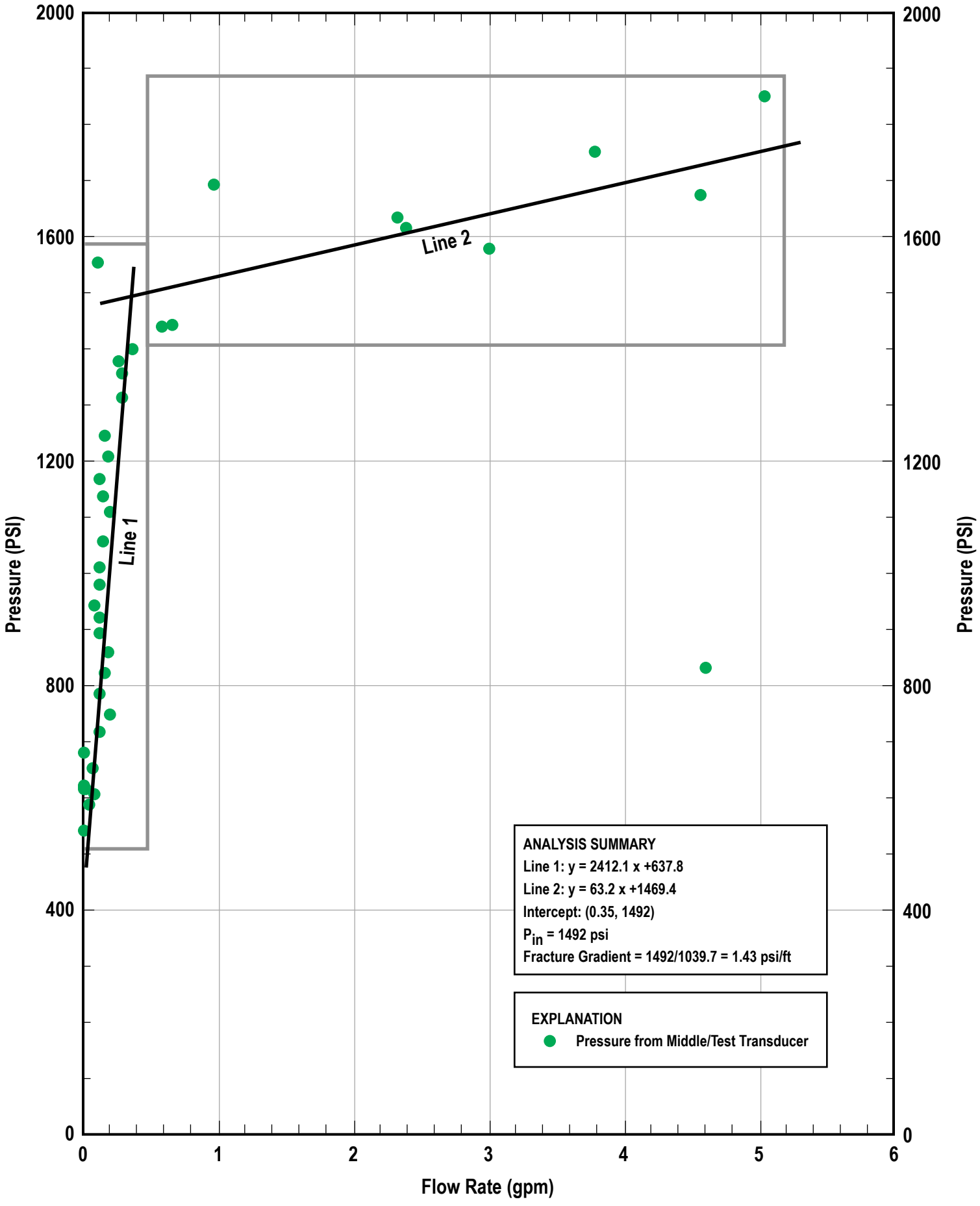
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 0950 to 1030 Hours - 1033 to 1039.7 feet below ground surface

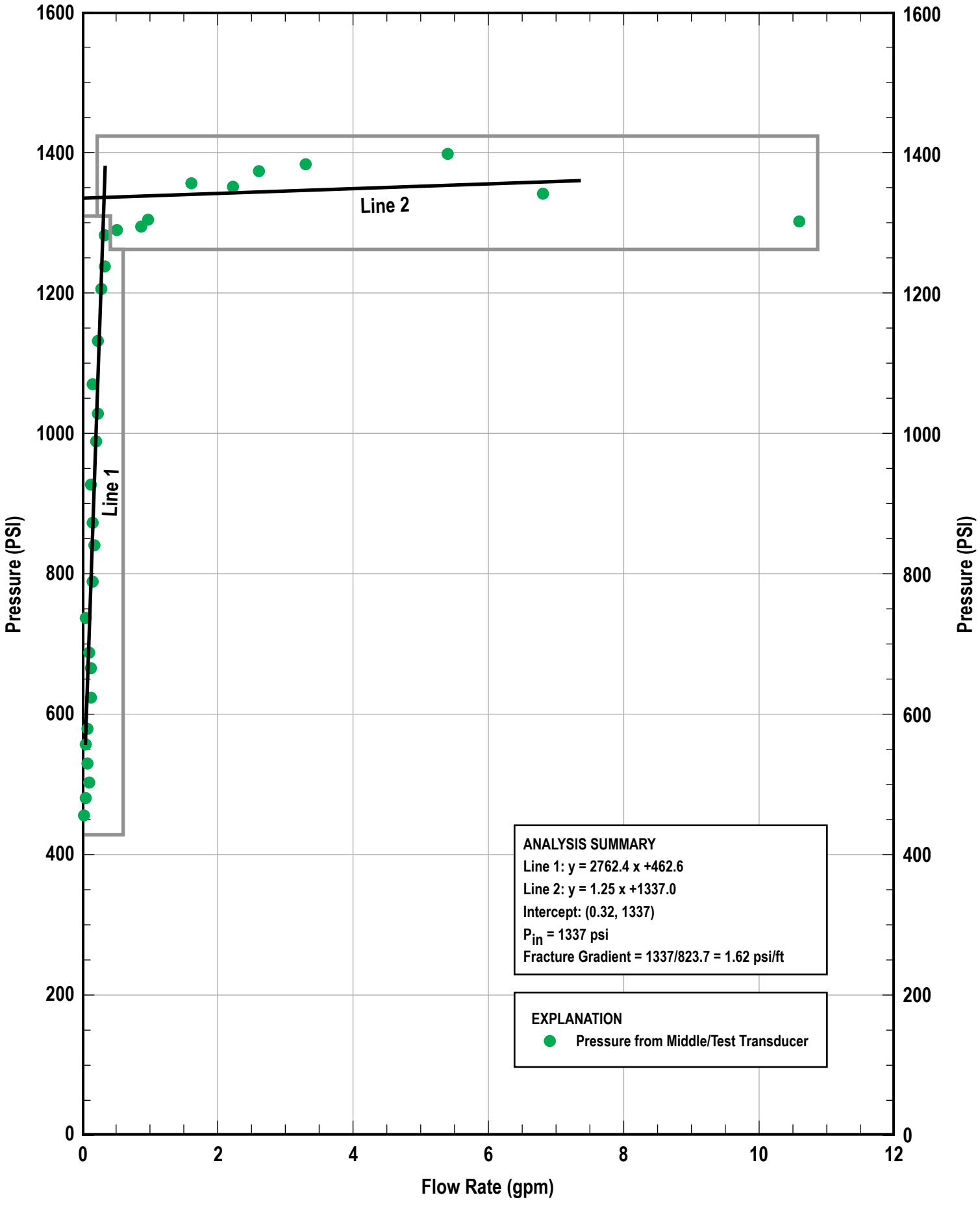
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1209 to 1230 Hours - 817 to 823.7 feet below ground surface

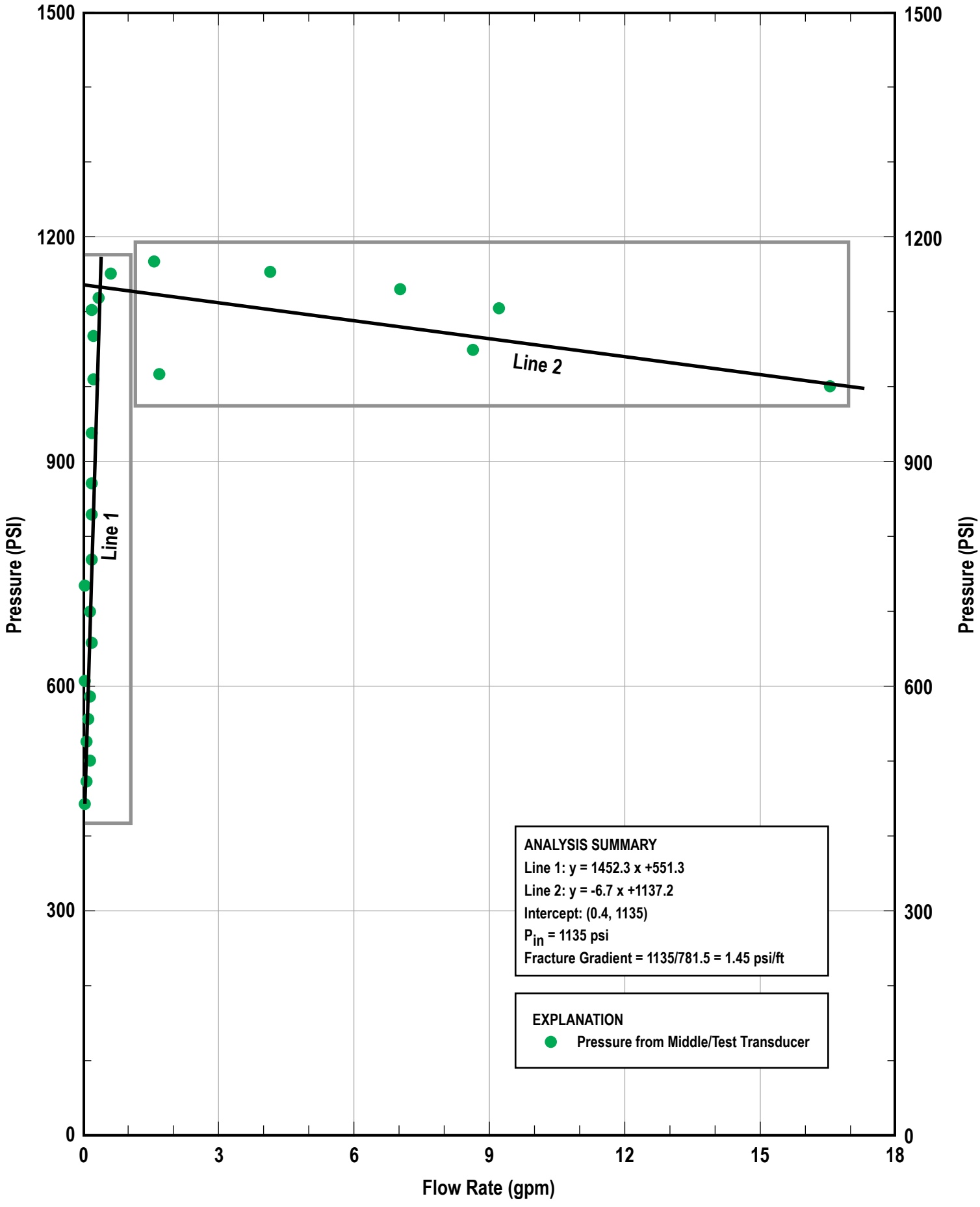
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1345 to 1400 Hours - 774.9 to 781.5 feet below ground surface

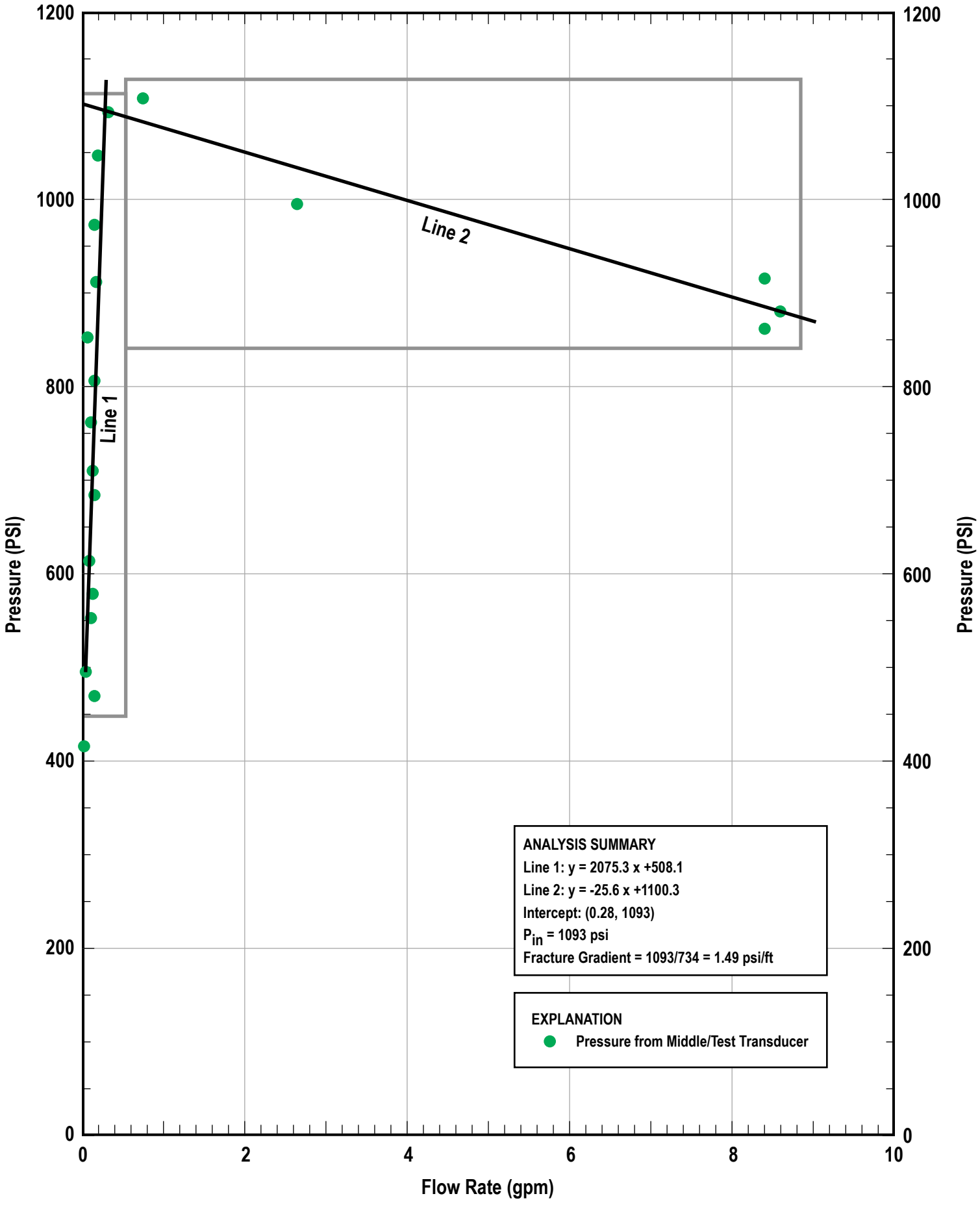
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1515 to 1525 Hours - 727.4 to 734 feet below ground surface

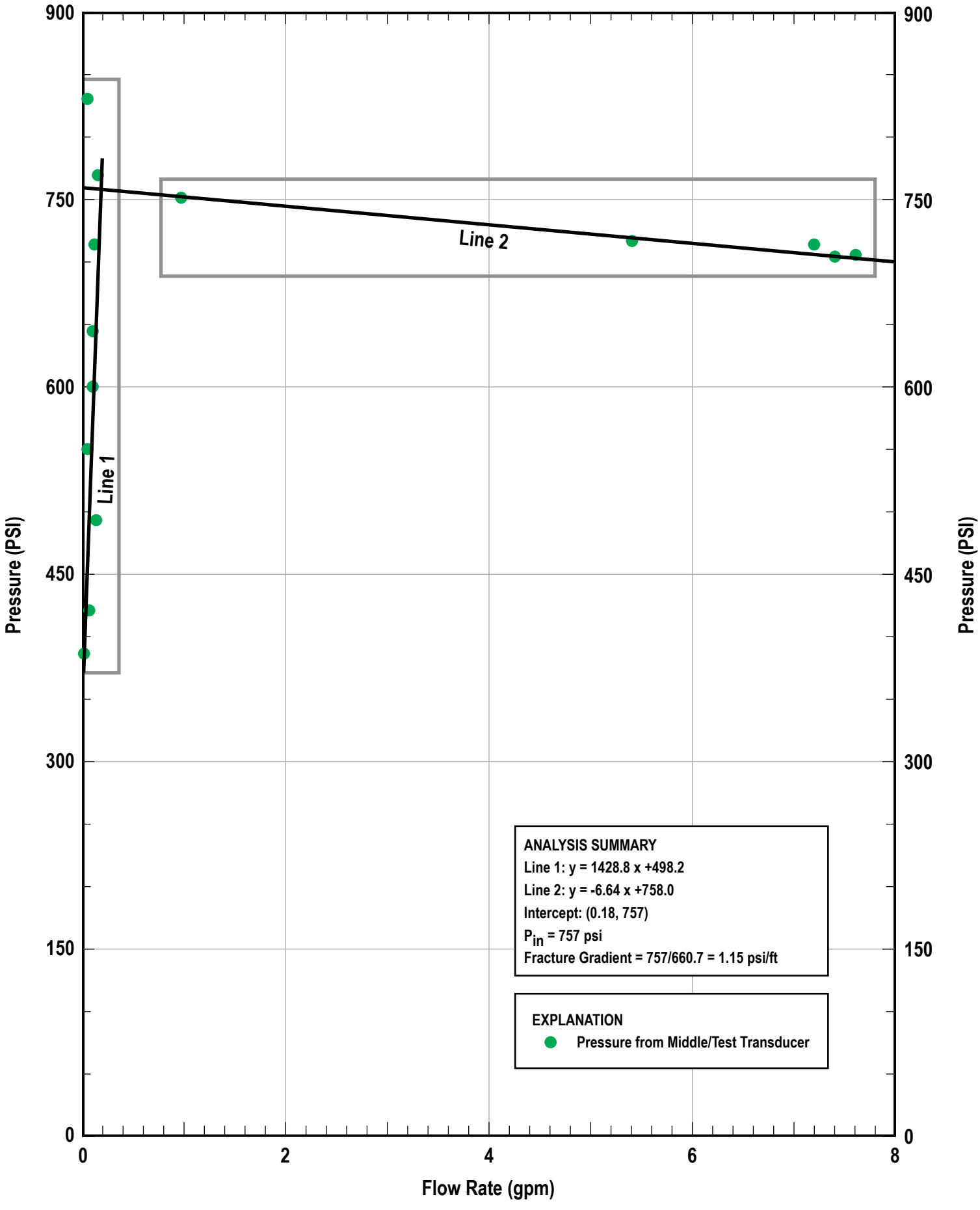
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSM-007

June 30, 2015 - 1615 to 1625 Hours - 654 to 660.7 feet below ground surface

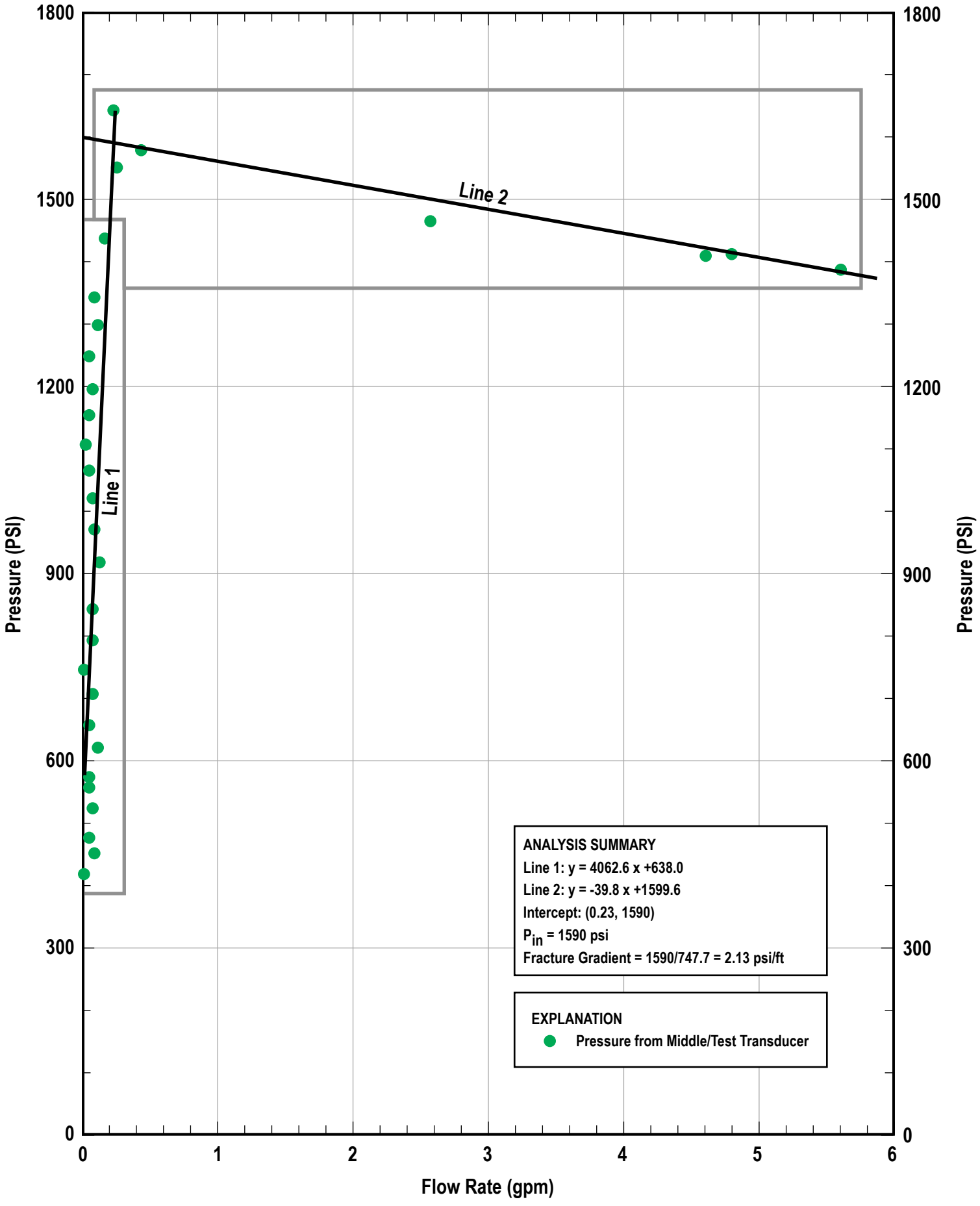
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-037

July 2, 2015 - 1309 to 1330 Hours - 740.4 to 747.7 feet below ground surface

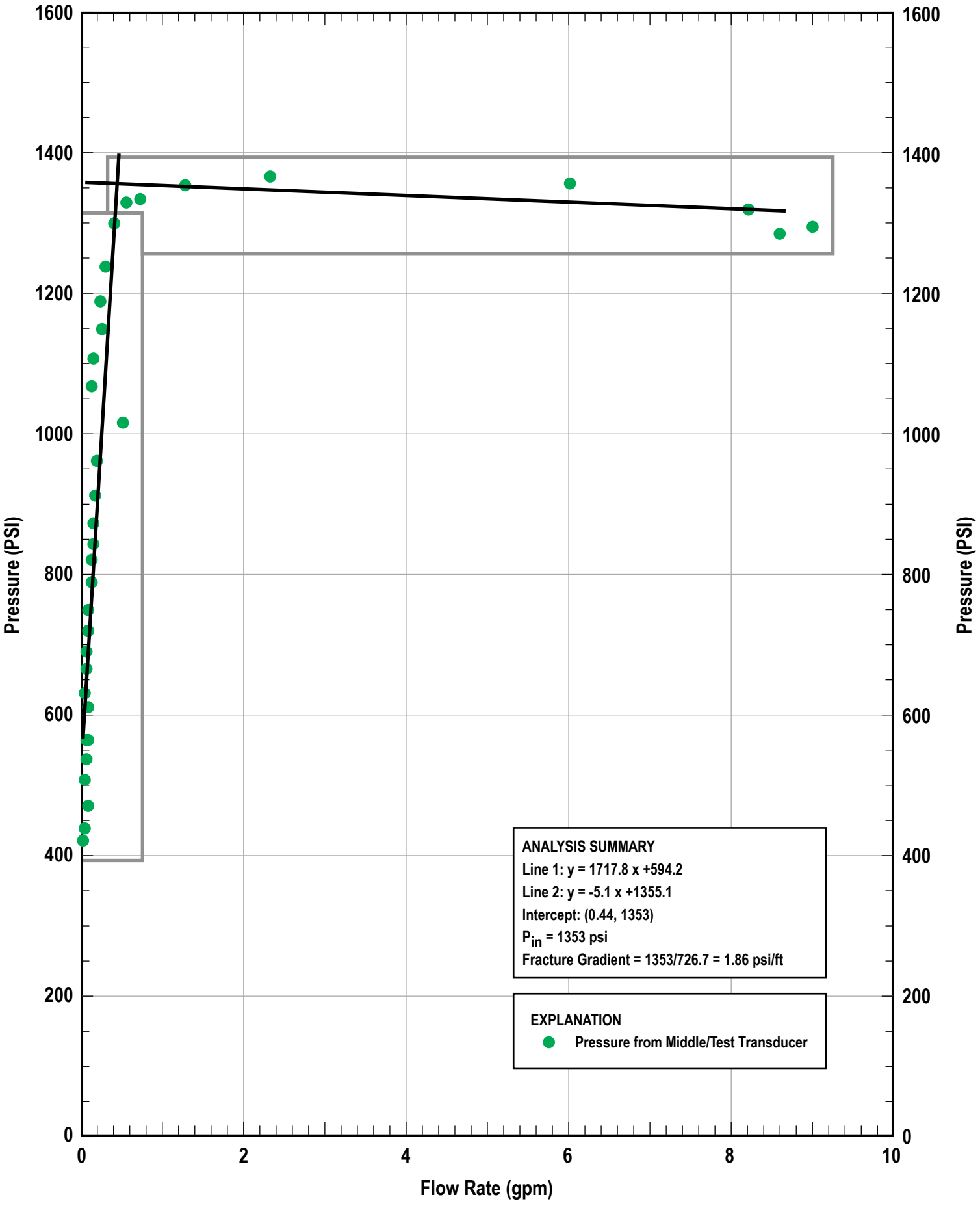
Formation Tested: Middle Abrigo



EXCELSIOR DRAGOON PROJECT - WELL NSD-037

July 2, 2015 - 1440 to 1505 Hours - 719 to 726.7 feet below ground surface

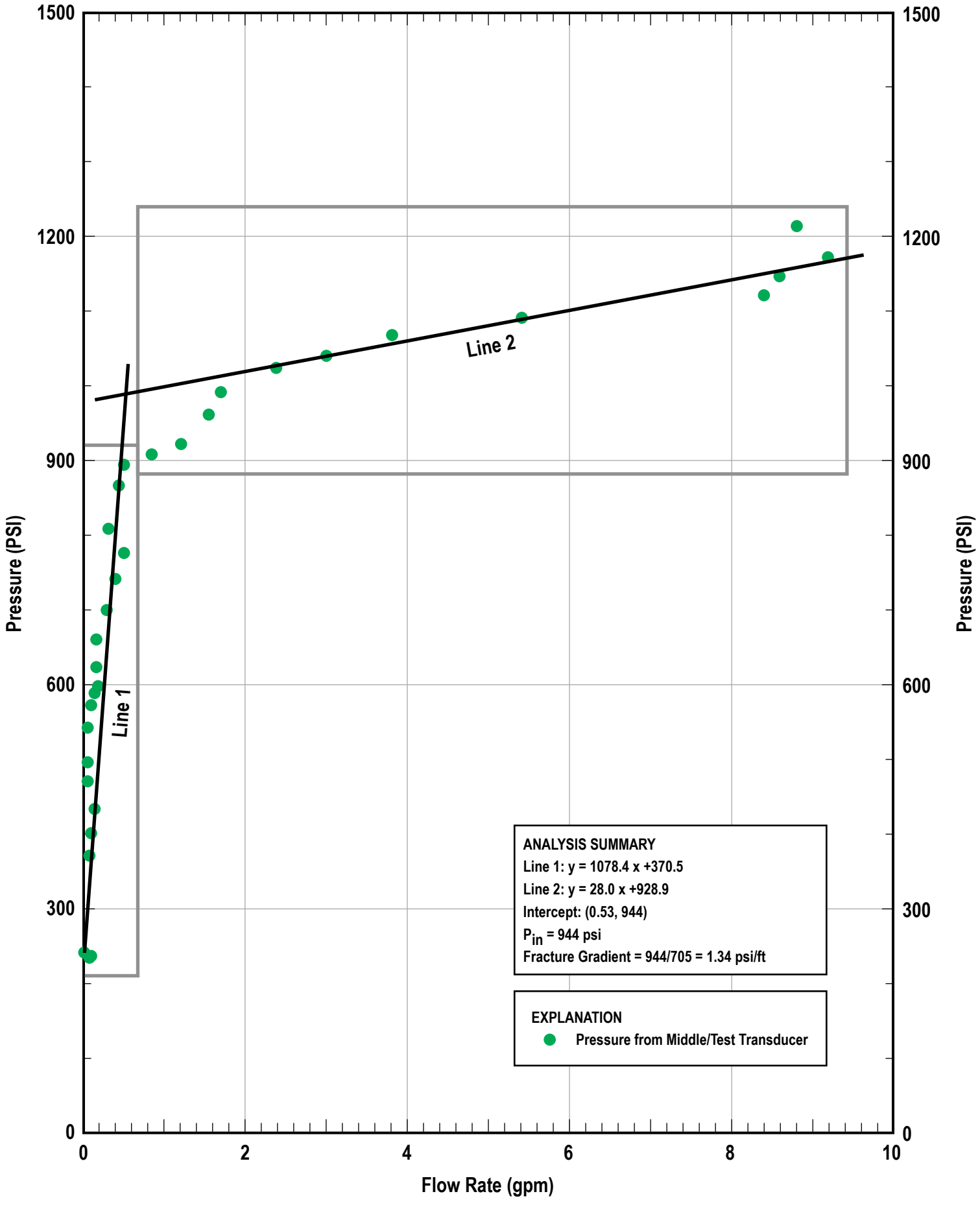
Formation Tested: Martin



EXCELSIOR GUNNISON PROJECT - WELL NSD-037

July 2, 2015 - 1627 to 1645 Hours - 698.4 to 705 feet below ground surface

Formation Tested: Martin



DIGITAL FILES